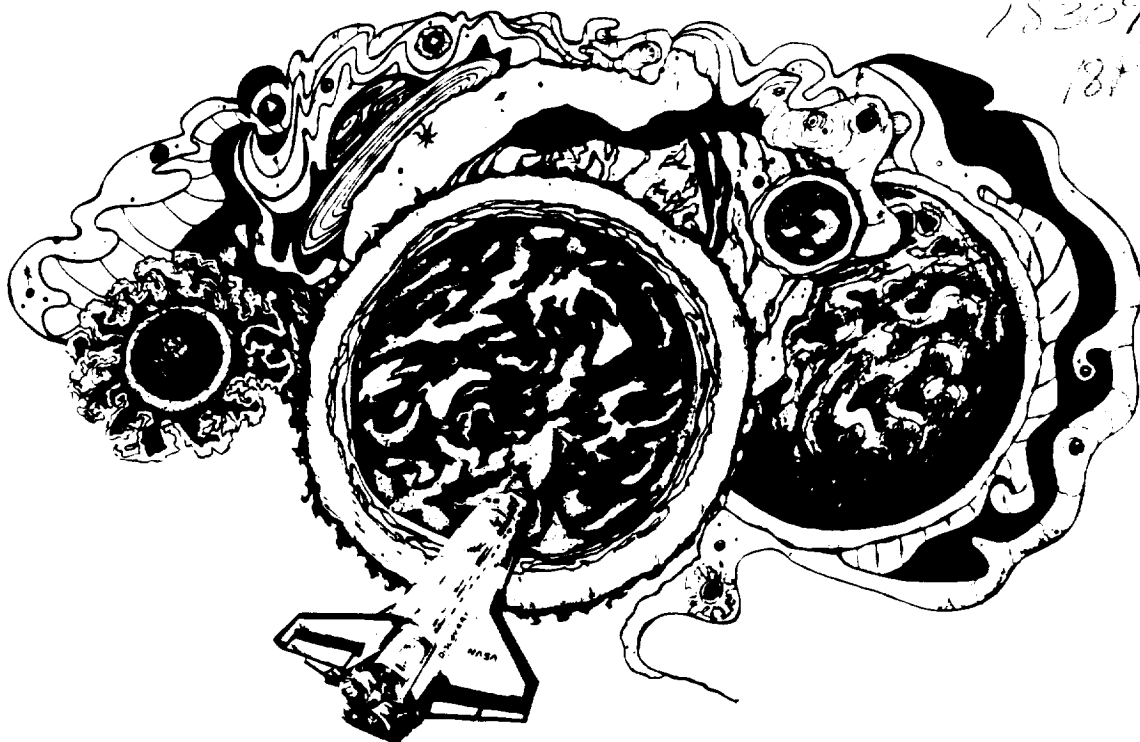


NAG5-1267



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(NASA-CR-196303) MAGNETIC EARTH  
IONOSPHERE RESONANT FREQUENCIES  
(NASA-MEIRF PROJECT) Progress  
Report (West Virginia State Coll.)  
98 p

N94-37461

Unclass

G3/32 0018309

**WEST VIRGINIA STATE COLLEGE  
COMMUNITY COLLEGE DIVISION  
NASA-MEIRF PROJECT  
PROGRESS REPORT JUNE 1994**

**MAGNETIC EARTH IONOSPHERE RESONANT FREQUENCIES**  
**NAG 5-1267**

Prepared for

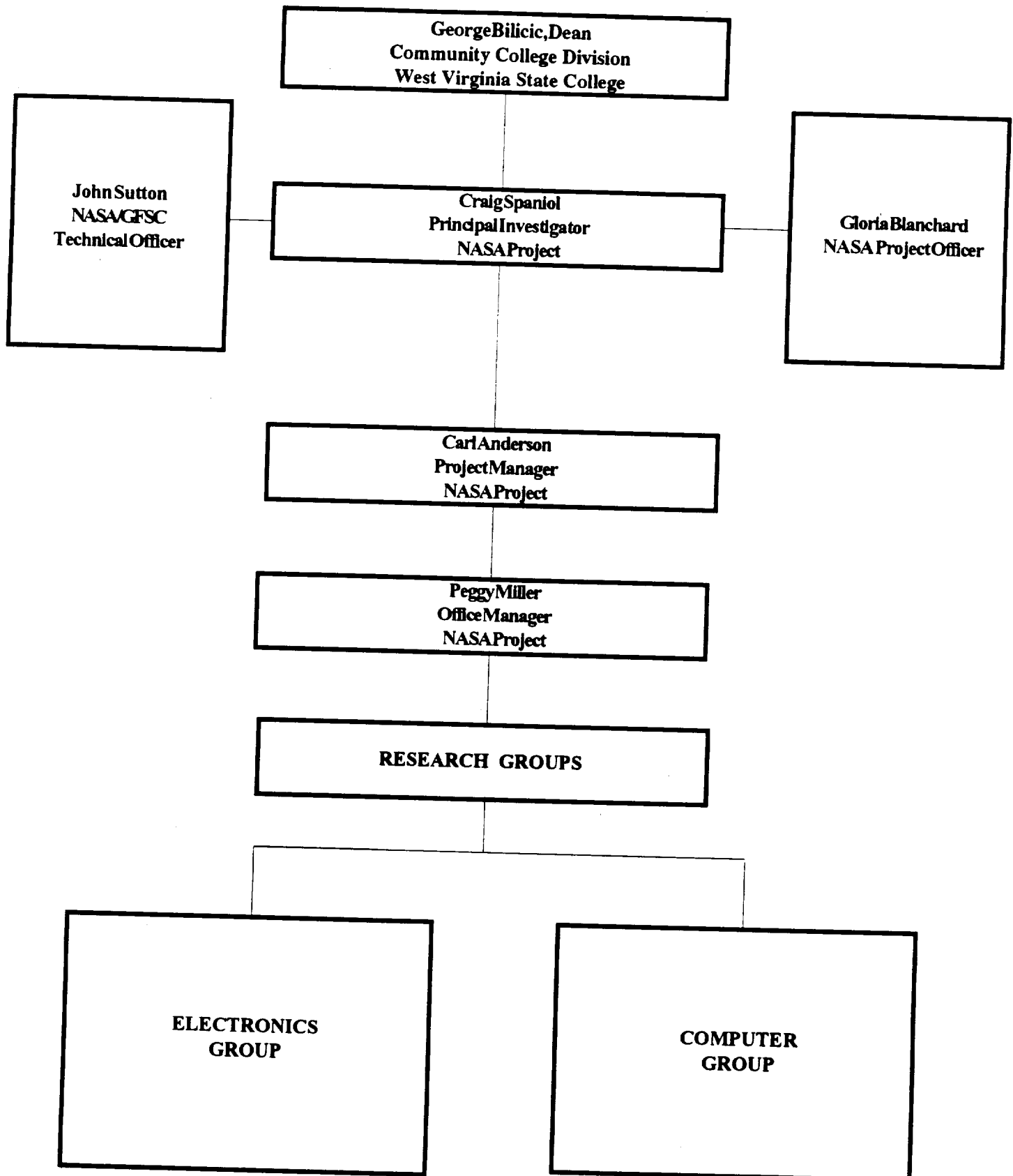
Dr. John F. Sutton  
Technical Officer, NASA Project  
Goddard Space Flight Center  
Greenbelt, Maryland 20771

Prepared by

Research Assistant Group  
NASA MEIRF Project  
Community College Division  
West Virginia State College  
Institute, West Virginia 25112

June 1994

# Project Organizational Chart



## PROJECT PERSONNEL

### Administration

Dean, Community College Division . . . Dr. George Bilicic

### Staff

Principal Investigator . . . . . Dr. Craig Spaniol

Project Manager . . . . . Carl Anderson

Office Manager . . . . . Peggy Miller

### Research Assistant Groups

Computer Group . . . . . Joe Adams \*

Barbara Adams

Tom Rowsey

Electronic Group . . . . . Bill Bailey

Janine Patterson \*

Bill Ross

\* Supports both groups

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**MESSAGE FROM DR. GEORGE BILICIC, DEAN  
COMMUNITY COLLEGE DIVISION  
WEST VIRGINIA STATE COLLEGE**

We at the Community College Division are pleased to report on progress of the NASA-funded research being conducted at West Virginia State College. This research activity continues to enhance the Community College Division's educational framework by offering an opportunity for our students to apply classroom technology in real-life situations. Additionally, papers continue to be published in journals and presented at international conferences on the theoretical work of the project thus disseminating research accomplishments of the project to the scientific community.

Educational motivation provided by the NASA Project research work is highly commendable. Although electromagnetic capability may not be a typical consideration of some students, the non-traditional student populace of the community college environment, many with industrial and technological backgrounds, is particularly interested in the development and implementation of these capabilities. We appreciate this research activity for stimulating student technological curiosity and providing a means of satisfying that curiosity.

This continued research effort has lead to the publication of yet another article by the principal investigator of the NASA Project and professor of Electronics Engineering Technology, Dr. Craig Spaniol, and the WVSC/NASA technical officer, Dr. John Sutton. Their successful publication of the third in a series of articles demonstrates our commitment to technological advancement in the community college component. The article, entitled "Electron Mass and Fields, III," was published recently in the international scientific journal, Physics Essays.

Our cooperative interaction with NASA - Goddard Space Flight Center over the years has had an extremely positive effect on technical educational activities at the Community College Division, as well as on contributions to the scientific community through the publication of research results. We welcome the opportunity to continue this interaction for many years to come.

## **OVERVIEW**

During this current reporting period, the project has focused on completing Phase I of the field monitoring work and documenting research accomplishments. Highlights of these efforts include presentations of papers at the annual joint meeting of the American Physical Society/American Association of Physics Teachers, April 18-22, 1994, in Crystal City, Virginia, and at the International Space, Time, and Gravitation Conference and Etoiles de L'Ecole Polytechnique Symposium, May 23-28, 1994, in St. Petersburg, Russia. These papers evoked considerable interest both here in the United States and abroad. Such interaction or feedback generated extensive material for future papers.

Field measurements of the background Ultra Low Frequency (ULF) electromagnetic spectrum in the New Mexico and Texas regions are most interesting. For some unknown reason, the signals are clearer (signal to noise ratio) in New Mexico than Texas, particularly around Taos. Also, the signal characteristics (signatures) are different within the New Mexico



area. We would like to enter the next phase of this work by establishing continuously operating stations in these areas.

The project has been approached through contacts at Goddard Space Flight Center by representatives of the Peruvian government. They wish to pursue a joint effort to establish ULF monitoring stations throughout Peru to monitor possible earthquake precursor signals. We certainly hope that sufficient funding is obtained to continue this fascinating research into the natural ULF properties of plant earth.

## **COMPUTER GROUP**

The computer group has major accomplishments during this reporting period. These tasks evolved from necessary changes and major additions made to the monitoring system in order to utilize an expedient method of collecting and analyzing data. These systems were upgraded with new communication packages that have enhancement capability.

The monitoring system database was flushed due to a virus that penetrated these systems. An upgrade package modifying current software was installed to protect against future virus infections. Recovery of lost time due to this flush was minimal since we initiated routine back-up procedures during the last reporting period. With these modifications in place we have expanded our data reduction capabilities.

Major advances in the use of the INTERNET system and its resources are in place. INTERNET provides an economical means of communication between members of the project, off-

campus contacts relating to our research effort, and our newly-acquired Russian counterparts.

This network has not only been used to make new connections through the utilization of E-Mail, but it also is used as a communications setup through electronic bulletin boards and other network systems. We are now using the net to access other research groups to exchange data. By initiating searches in the net for data relating to our research, any pertinent information located on the net can be viewed and sections applicable to our research downloaded automatically. This capability has added a new dimension to our research effort.

The use of the MU-SPIN System (Minority University - Space Interdisciplinary Network) of computers, with the help of Mr. James Harrington, Goddard Space Flight Center, will also provide us with a pathway for expanding our communication and analytic capabilities. MU-SPIN may provide us with a means to view rapidly incoming data (spectrum traces from the field monitoring site) while allowing

us to compare and compress these data more efficiently. Use of the MU-SPIN supercomputer access will expedite this task. Such improvements in our data collection and analyzation process is vital to our continuing research effort.

## **ELECTRONICS AND FIELD WORK**

Earlier experiments at West Virginia State College monitoring the Earth-Ionosphere cavity for Resonant Frequencies provided us with inconsistent results. This was primarily due to the cavity signal-to-noise ratio at our College site. Noise in this case was electromagnetic energy, emanating from man-made devices such as electric motors, fluorescent lights, computers, et cetera. Our main computers, electronic lab, and offices are located at the College.

Therefore, a remote monitoring site was set up at Hurricane, West Virginia, using a Hewlett Packard 35660-A Dynamic Spectrum Analyzer to monitor the Extremely Low Frequency (ULF) spectrum. A Krohn-Hite model 3343 filter was used to limit the bandwidth of the spectra entering the analyzer to 27 Hz. The HP-35660A was set to display spectra between 3 Hz and 30 Hz. At times the interference level was still high, causing the signal to be lost in the ambient noise.

Using the equipment listed above plus a Hewlett Packard 3560A Portable Spectrum Analyzer, other remote sites were investigated. The remote equipment was set up in different states from West Virginia south to Florida then west to New Mexico and Kansas, testing not only for a low noise site, but also to determine if the geographic location had a bearing on the cavity signal characteristics.

We are continuing to look for a suitable location to set up a more permanent monitoring station. Work is ongoing to improve the sensors used to receive ULF signals. We are also selecting the optimum equipment configuration and upgrading software programs that control the instrumentation system and analyzes received data.

### **CURRENT WORK**

The resonant frequencies, according to the work done by the German physicist W. O. Schumann in 1952, starts at about 8 Hz. Due to continuous flexing of the cavity, signals will move about 1/2 Hz above or below the mean frequency.

Eight hertz ( $7 \frac{1}{2}$  Hz to  $8 \frac{1}{2}$  Hz) signals varies between -85 dBVrms and -95 dBVrms. In some areas the noise floor is in this same area making it difficult to separate cavity frequencies from noise. Monitoring in Texas and New Mexico has produced the best results to date. The noise floor in these areas was very low, about -110 dBVrms. This number varies greatly over time, although it does seem to stabilize over the thousands of traces recorded so far.

How this sensitivity is linked to the type of sensors and amplifying equipment is not yet known. Once a permanent remote site is established where continuous monitoring can occur, the data analysis should give us a good picture of the frequency drift, strength, and direction of the cavity's resonant frequencies.

### **REMOTE-ONE**

Remote-one is housed in a trailer that is 6 feet wide, 6 feet high inside, and 10 feet long. This trailer has been wired with 110 Volt outlets along with telephone lines. The trailer has external connections for telephone, power, and coaxial

cables for the various sensors and antennas.

A Hewlett Packard 35660A Dynamic Spectrum Analyzer is the main piece of equipment. A Hewlett Packard 9153C Hard Disk Data Storage Device is connected to the HP-35660A where the recorded traces are collected. A Krohn-Hite model 3343 filter limits the bandwidth of the spectra entering the analyzer. The computer that controls the system is an AT&T PC 6300. A Hewlett Packard 82335A Interface allows the computer to communicate with the Hewlett Packard 35660A Dynamic Spectrum Analyzer. A Radio Shack model 26-1208A cassette recorder and a Novex FG-2020A Function Generator are used to record the raw data. In addition, a variety of miscellaneous equipment and tools make up the mini-electronic lab on wheels.

Software that controls the system was written by the computer group. Sensors, pre-amps, post-amps, and components that interface the raw data recording devices were constructed by the electronics group.



The following is a brief description of what happens during a day with Remote-One. The system operates in a loop, so we will start with when the system resets itself. This occurs once or as many times in any twenty-four hour period as is set by the team. First, if there is a new compressed file from the main office at the College, it is unpacked and the expanded files are sent to the appropriate sub-directories of the computer. Messages are sent to the sysop's computer, and if a new definition file was unpacked it replaces the previous one in the control sub-directory. Then, other housekeeping routines are run to prepare the system for monitoring operation. The HP-35660A is then set up using parameters in the system's definition file. Traces are recorded at intervals set by the definition file. These traces are collected and moved to the computer's active memory where they are compressed along with any messages for the Principal Investigator or others at the office or lab.

The compressed file is identified with a code that indicates the date and location plus other pertinent information. The computer then automatically opens a

communication link and waits for the main computer to call. During contact with the main computer at the College, compressed files are transferred bidirectionally. When transmissions are completed the communications link is automatically terminated. The remote computer then calls the sysop's computer and transfers any new messages or updates of files that control the overall system. The system then resets itself and the loop continues.

This software was written in such a way as to allow a greater flexibility in control of the individual components of the monitoring system. Other software at the main office can be used to write files that control the overall system and configuration file that is used to parameterize the HP-35660A. Copies of these compressed files are stored at both the remote site and at the main office. Representative traces are contained in Appendix A.

## **COMMUNITY COLLEGE DIVISION OPEN HOUSE**

The NASA-MEIRF Project participated in the Community College Division Open House and Career Information Day held on March 15, 1994 (Appendix B). This event was designed to familiarize campus students, area high school students, and the public, in general, with the Community College Division of West Virginia State College and all it has to offer. Those in attendance were allowed to observe actual classroom sessions and were given the opportunity to speak with advisors and representatives of all departments about questions they had pertaining to various fields or activities.

The Project's presentation in the Open House was very successful and provided an excellent opportunity to interact with the student population, current and future, as well as with campus faculty and staff. Several posters were displayed giving general background information on the goals and objectives of the research activity. Other posters illustrated the nature of research being conducted here at West Virginia

State College and was of particular interest to those who were not familiar with the enormous range of research possibilities.

The computer group designed a software program to inform those visiting the NASA Project display area of the equipment and advanced technology concepts being utilized by the project in the "field". This program displayed not only why it is used, but also how it works. The graphics used in the illustration were informative and the overall program animation was enjoyed by all.

Approximately 400 people took advantage of this opportunity to come out and meet the college. The NASA Project was pleased to have the opportunity to reach so many with its research results and objectives. Some of the groups in attendance other than WVSC students, staff, and faculty were: Nitro High School, Poca High School, Sissonville High School, Herbert Hoover High School, McKinley Junior High School, the ONOW Program of Putnam County Technical Center, Project NEST of Kanawha County, Sojourners Homeless Shelter, and St. Paul's Baptist Church.

Considering the large turnout and the number of participants, this event was truly a success. Those who stopped by the NASA Project table expressed an interest in returning next year because they enjoyed the Open House immensely and had learned so much about the Community College Division and the NASA Project. Hopefully, an Open House and Career Information Day will become a semi-annual event.

## **PANEL DISCUSSION PROGRAM**

Dr. Spaniol was invited to make a presentation at the Panel Discussion Program hosted by the Committee on International Understanding at West Virginia State College concerning travel to St. Petersburg, Russia, . The Panel Program was held on February 22, 1994, at the Wilson College Student Union building. Dr. Spaniol was one of four faculty members making a presentation on their travel to St. Petersburg during the year.

This program was well attended and presentations covered many varied aspects pertaining to St. Petersburg. While Dr. Spaniol primarily addressed the scientific topics of research and technology in the Russian community, others on the panel reported more on cultural experiences.

Each participant took several minutes explaining to the audience their reasons for visiting St. Petersburg, then shared insights, surprises, and highlights of their international interaction to which the audience was very receptive.

The question-answer session after each presentation, as well as at the end of the program, showed much interest and concern for the Russian community. The program was very successful in informing the campus students, faculty, and staff of West Virginia State College's interaction with St. Petersburg, Russia.

## **SPACE, TIME, GRAVITATION CONFERENCE**

During the current period, Dr. Spaniol and Dr. Sutton were invited to present a paper at the International Conference on Space, Time, and Gravitation and the Etolles de L'Ecole Polytechnique Symposium hosted by the Russian Academy of Sciences, the Research Institute of Radio and Electronics, and the Institute of History of Science and Technology. The conference and symposium were held May 23 through May 28, 1994, in St. Petersburg, Russia. Dr. Sutton was unable to attend the conference; however, Dr. Spaniol accepted the invitation and presented the paper titled "Triplet Solution of the Twin Paradox." (Appendix C).

This paper was one of several invited papers that addressed paradoxes associated with Einstein's 1905 formulation of the special theory of relativity. The paper was well received and created much interest in the application of Einstein's special theory of relativity.

Although none of the other project staff were able to



attend the conference, Dr. Spaniol's wife, Wanda, and two sons, G.C. and Michael, were able to accompany him to Russia. While Dr. Spaniol and Michael attended the relativity conference presentations, Wanda and G.C., who are employed at the Thomas Memorial Hospital, visited medical facilities in the St. Petersburg area. The trip to Russia proved to be beneficial to all.

Interaction continues with scientists in attendance. Scientists representing not only Russia and the United States, but also France, Greece, Argentina, Japan, Finland, Canada, Austria, Germany, Spain, China, and England presented research papers relating to space, time, and gravitation. Considerable discussion during the question and answer sessions after each presentation proved to be noteworthy and informative.

Over 200 attended conference and many new contacts were made. Communication with the international community continues to be a resource to the researchers here at West Virginia State College.

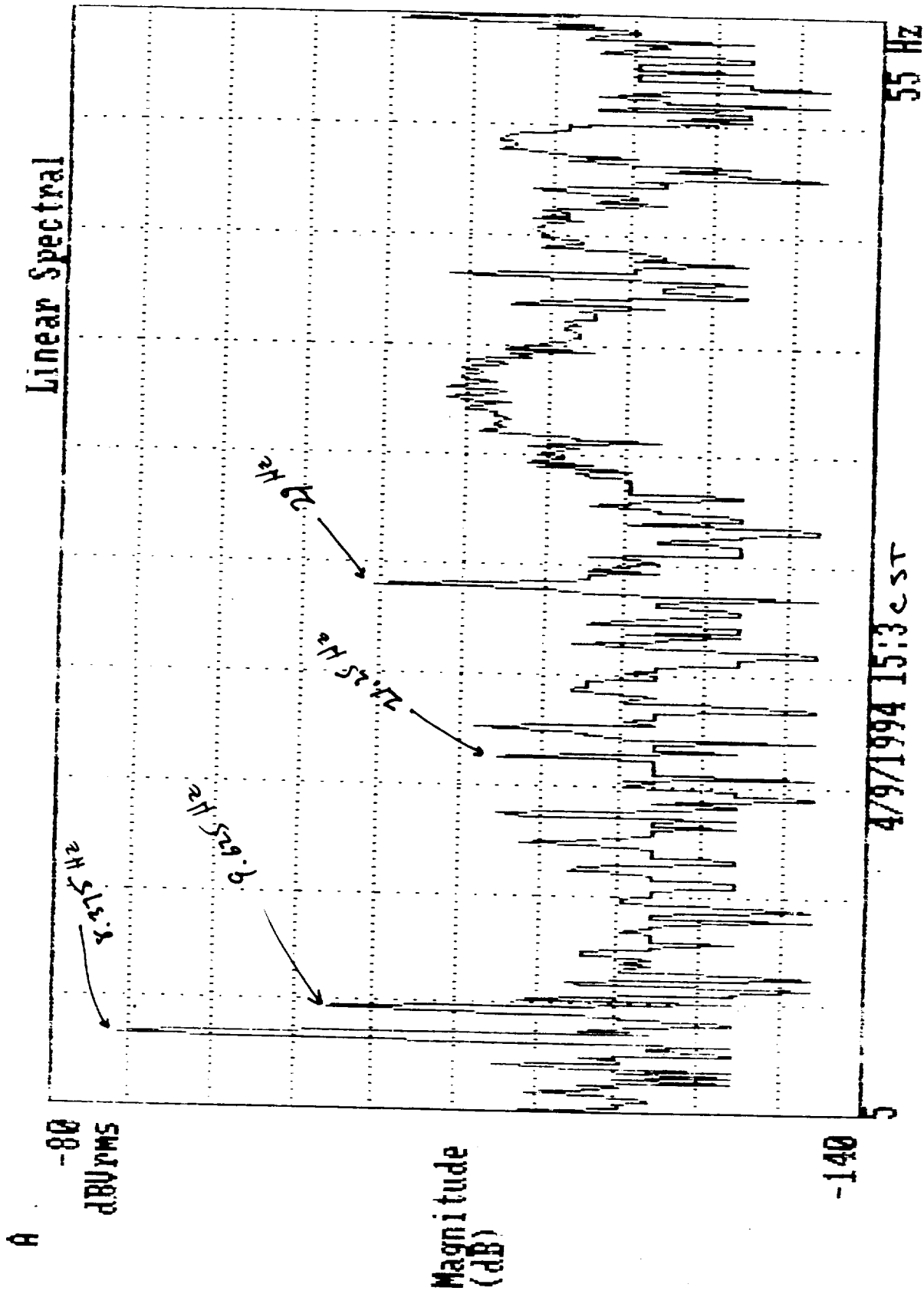
## **PUBLICATIONS**

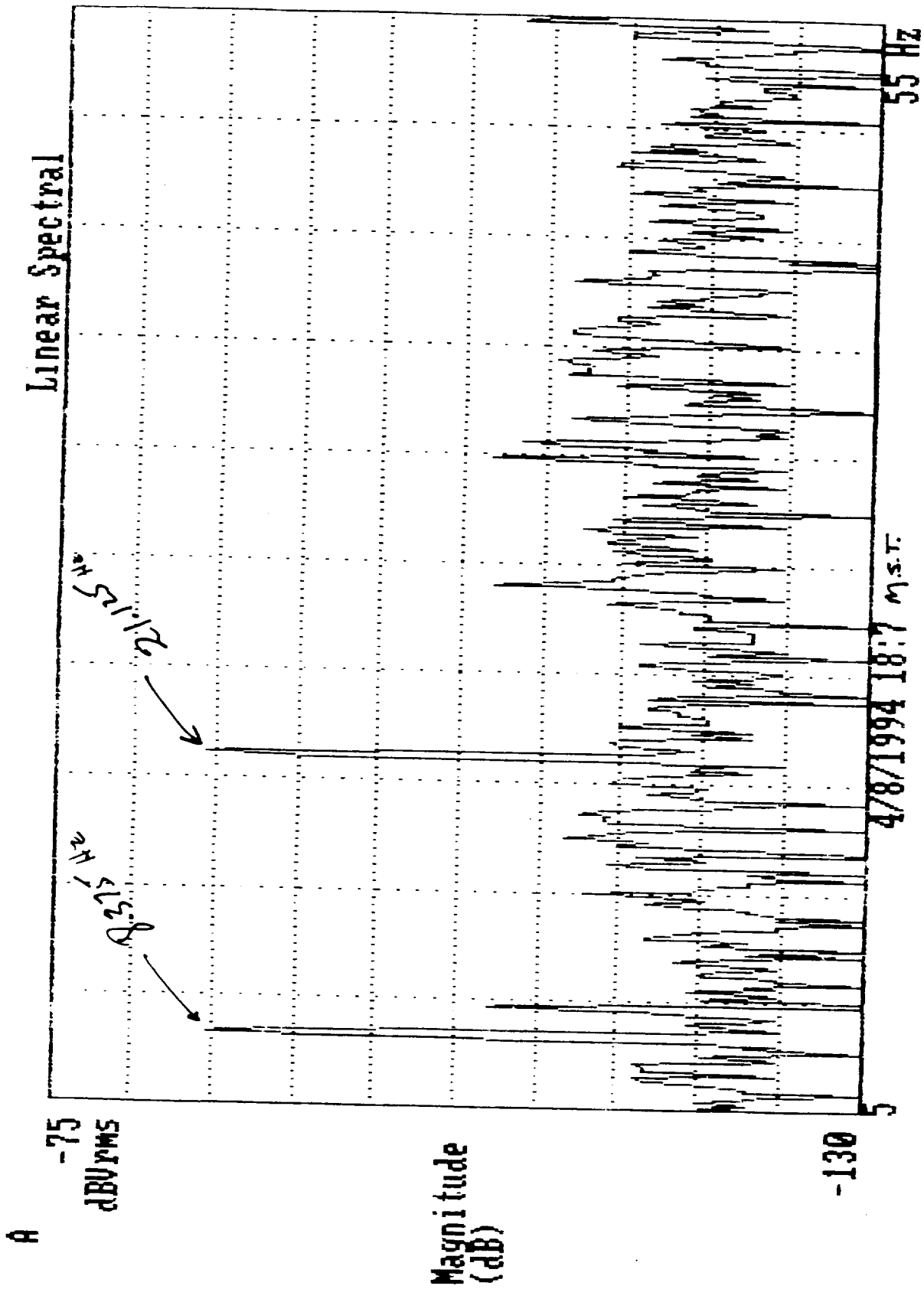
The ongoing project effort to improve received resonant cavity signals for ELF research has lead to the publication of yet another article by the principal investigator of the NASA Project and professor of Electronics Engineering Technology, Dr. Craig Spaniol, and the WVSC/NASA technical officer, Dr. John Sutton. They have successfully written the third in a series of articles on the theoretical work being conducted at WVSC. The article, entitled, "Electron Mass and Fields, III," (Appendix D) was published in the international scientific journal, Physics Essays, Volume 6, Number 2.

This article completes the development of an electrical circuit model of the electron. It includes the latest recommended values of the physical constants and a method for calculating the Lamb shift. In addition, the model was used to calculate a cut-off frequency for Sakharov's stochastic electrodynamic (SED) theory of the electron and submitted to Physical Review A.

## ***APPENDIX A***

*Spectral Data Plots*

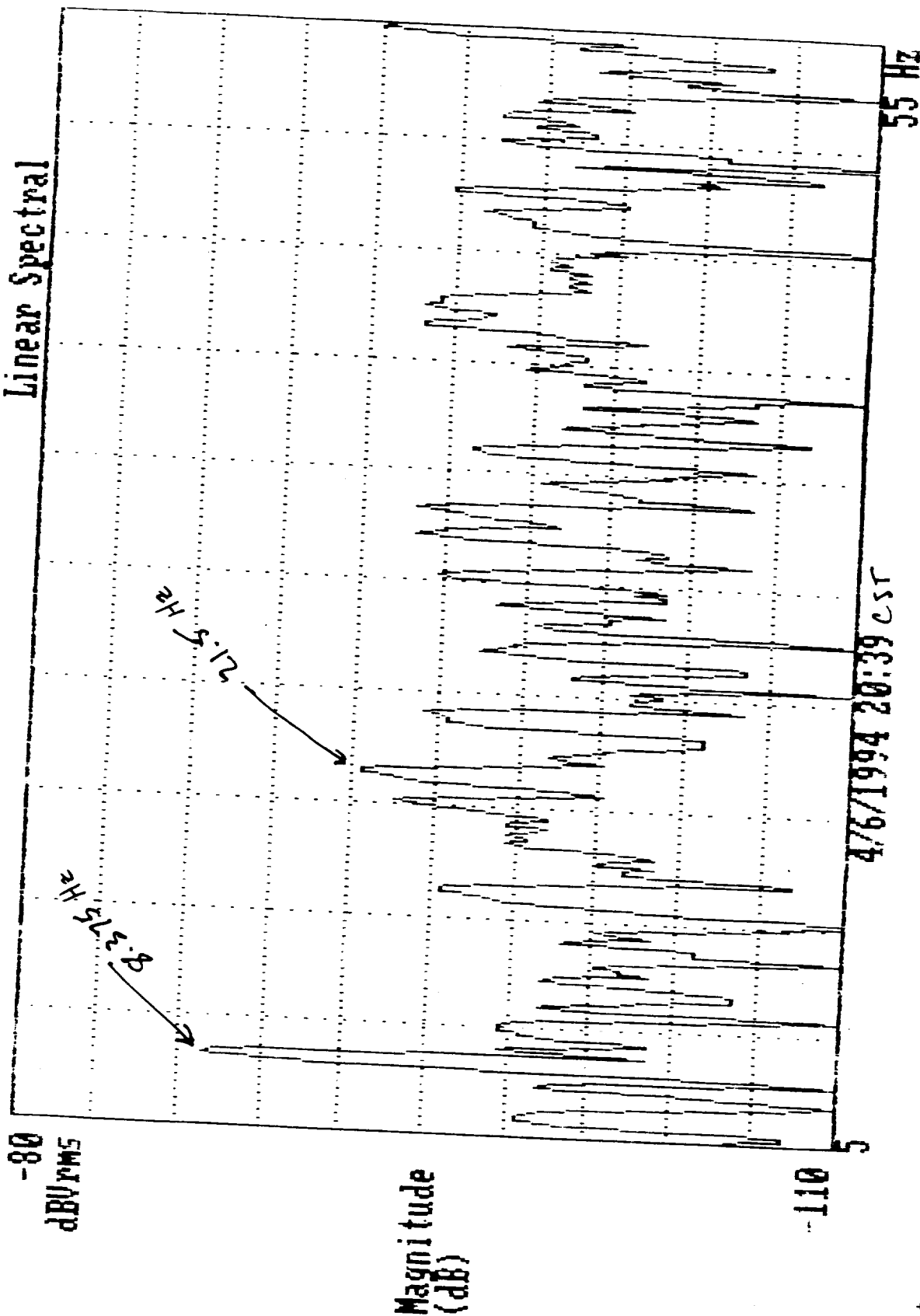




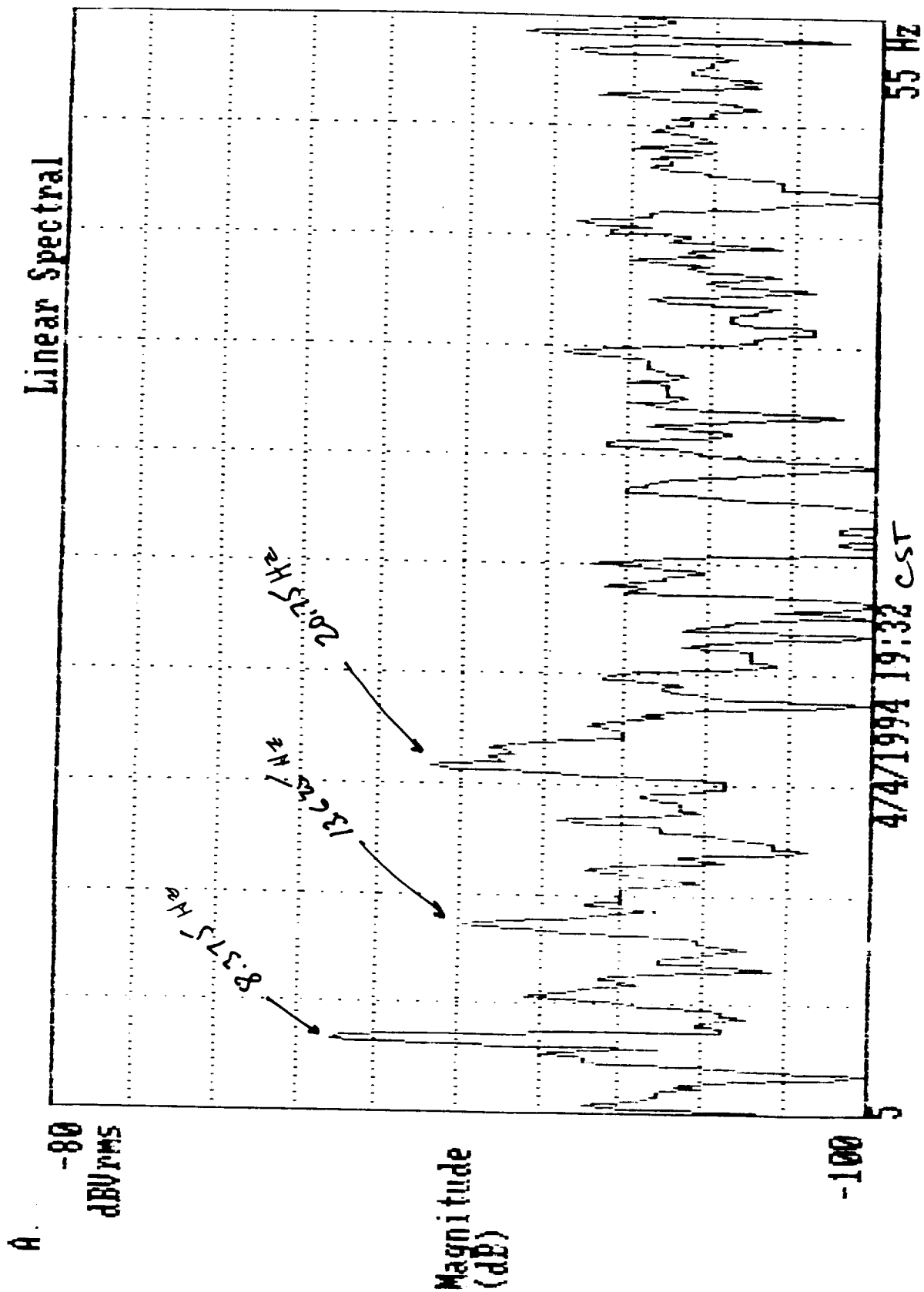
A

-80  
dBVrms

Linear Spectral



Earth-Ionosphere Cavity  
Spectrum Plot #2  
Taos, NM  
April 6, 1994



## ***APPENDIX B***

*COMMUNITY COLLEGE DIVISION OPEN HOUSE*

*March 15, 1994*



## About West Virginia State College

Founded in 1891, West Virginia State College is the largest institution of higher education in the Kanawha Valley. Located in the state's center of population, government, and commerce, the College acts as a major resource for the metropolitan area as well as the entire state.

## Community College Division of West Virginia State College

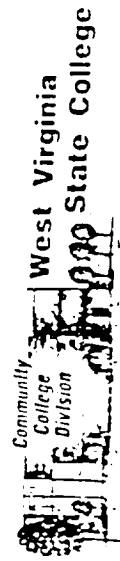
The Community College Division is the administrative unit responsible for giving leadership for the development and delivery of associate degree programs and Continuing Education and Community Service programs and activities. The Associate in Arts and the Associate in Science degrees are designed for students who plan to transfer to baccalaureate degree programs. Associate in Applied Science degrees are career-oriented and are designed to prepare students for immediate entry into the job market as well as for transfer to four-year degree programs. Associate degrees are available in a variety of subject areas.

Community College Division  
West Virginia State College  
PO Box 1000 - Campus Box 183  
Institute, WV 25112-1000  
(304) 766-3118

Community College Division  
West Virginia State College  
PO Box 1000 - Campus Box 183  
Institute, WV 25112-1000  
230

# Open House & Associate Degree Career and Information Day

Tuesday, March 15, 1994  
10:00 am - 7:00 pm  
Thomas W. Cole Jr. Complex



## West Virginia State College Community College Division

### Open House & Associate Degree Career and Information Day

- ☐ Investigate Associate Degree Programs
- ☐ Sit in on actual classes in session
- ☐ See laboratories in action
- ☐ Talk with Associate Degree Advisors and Program Directors
- ☐ Speak with working professionals who are *accountants, managers, office administrators, chemical technicians, computer-aided draftspersons, electronics technicians, nuclear medicine technologists, etc.*
- ☐ Obtain admission and financial aid information
- ☐ Visit other campus facilities
- ☐ Meet graduates of associate degree programs who are working in the degree field
- ☐ Pick up brochures and other campus literature
- ☐ See state-of-the-art Educational Network studio

**REFRESHMENTS WILL BE SERVED  
FREE AND OPEN TO THE PUBLIC**

*Meet representatives from Continuing Education, George Washington Carver Partnership, Workforce Training and Economic Development, Job Training and Partnership Act (JTPA), Metro Area Agency on Aging, NASA Project, and Phi Theta Kappa (PTK) Honor Society*

## WVSC Associate Degree Programs

- ☐ Associate in Applied Science
- ☐ Associate in Arts
- ☐ Associate in Science
- ☐ Accounting
- ☐ Architectural Drafting Technology
- ☐ Banking and Finance
- ☐ Chemical Technology
- ☐ Communications
- ☐ Computer-Aided Drafting and Design
- ☐ Computer Science
- ☐ Criminal Justice
- ☐ Electronics Engineering Technology
- ☐ Gerontology
- ☐ Hospitality Management
- ☐ Legal Assisting
- ☐ Management
- ☐ Marketing
- ☐ Medical Assisting
- ☐ Merchandising
- ☐ Nuclear Medicine Technology
- ☐ Occupational Development
- ☐ Office Administration

### Pre-Professional Courses

- ☐ Pre-Dentistry
- ☐ Pre-Engineering
- ☐ Pre-Law
- ☐ Pre-Nursing
- ☐ Pre-Optometry
- ☐ Pre-Pharmacy
- ☐ Pre-Veterinary

## Admission Requirements

The West Virginia State College Community College Division accepts all graduates of West Virginia schools, or holders of General Education Certificates (GED), or out-of-state students who have a high school diploma and a minimum grade point average of 2.0 or a minimum of 17 on the ACT.

### Financial Assistance

For information on grants, loans, and scholarships, contact the West Virginia State College Financial Aid Assistance Office at 766-3131.

For more information about the West Virginia State College Community College Division Open House & Associate Degree Career and Information Day, contact

Phyllis Holsclaw 766-3220  
Bertlela Montgomery 766-3191  
John Rogers 766-3119

**West Virginia State College  
is handicap accessible**

**West Virginia State College is an  
Equal Opportunity/Affirmative  
Action Employer**

## ***APPENDIX C***

*SPACE, TIME, GRAVITATION CONFERENCE*

*and*

*ETOILES DE L'ECOLE POLYTECHNIQUE SYMPOSIUM*

*May 23 - May 28, 1994*

**RUSSIAN ACADEMY OF SCIENCES  
RESEARCH INSTITUTE OF RADIO AND ELECTRONICS  
INSTITUTE OF HISTORY OF SCIENCE AND TECHNOLOGY**

**INTERNATIONAL CONFERENCE  
SPACE, TIME, GRAVITATION**

**SYMPOSIUM: ETOILES DE L'ECOLE  
POLYTECHNIQUE**

**PROGRAM AND ABSTRACTS**

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**May 23—28, 1994, St.-Petersburg, Russia**

## Scientific Organizing Committee

S. Griгорian ,	Russia	Co-chairman
D. Pestre ,	France	Co-chairman
V. Abalakin ,	Russia	
G. Aldoshin ,	Russia	
C. Antonopoulos ,	Greece	
A. Efimov ,	Russia	
A. Guillerme ,	France	
J. Guila ,	Argentina	
D. Gouzevich ,	Russia	
I. Gouzevich ,	Russia	
H. Hayasaka ,	Japan	
B. Ivanov ,	Russia	
T. Jaakkola ,	Finland	
V. Jakovlev ,	Russia	
W. Van der Kamp ,	Canada	
K. Manuylov ,	Russia	
S. Marinov ,	Austria	
M. Muller ,	Germany	
V. Nalivkin ,	Russia	
N. Nevskaya ,	Russia	
D. Pavon ,	Spain	
X. Shaozhi ,	China	
A. Shpitalnaya ,	Russia	
C. Spaniol ,	USA	
M. Sutcliffe ,	England	
S. Tolchelnikova ,	Russia	
M. Varine ,	Russia	

Local Organizing Committee

M. Varine	Chairman
A. Spitalnaya	Secretary
H. Chebotareva	
G. Dubar	
A. Efimov	
H. Filatova	
R. Keys	(Canada)
K. Manuylov	
S. Tolchelnikova	
J. Voronov	

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# VIII

15.20 - 15.40	
15.40 - 16.00	Break
16.00 - 16.20	L. Syedov On the theory of gravitation in Riemannian spaces.
16.20 - 16.40	C. Spatiol . J. Sutton Triplet solution of the twin paradox.
16.40 - 17.00	G. Sukhorukov, V. Sukhorukov, R. Sukhorukov Establishing of unified laws for atoms and the universe on the basis of Newton's ideas of space and time.
17.00 - 17.20	A. Staroverov Space is the antipode of matter.
17.20 - 17.35	V. Naumenko Ether and matter.

- 24 -  
consequences and limiting cases.

Spaniol C. and Sutton J.  
TRIPILET SOLUTION OF THE TWIN PARADOX

This paper investigates relativistic effects between inertial reference frames that are moving at different velocities. The focus is on measurement of space (distance) and time (intervals) within each inertial frame as well as relative to each other. The radar Doppler effect is applied to calculate total (down and return) frequency shift and extrapolate a relativistic Doppler shift, length contraction and time dilation formulas. A preferred or zero reference frame concept is addressed in terms of total system momentum and each moving inertial frame velocity is referred to this zero total system momentum frame. Relativistic changes in space and time measurements within each inertial frame are calculated with velocities referenced to this defined zero reference frame. Space and time measurements between individual reference frames are calculated through the zero reference frame. This approach permits relativistic effects to be calculated in a stepwise manner from a local zero momentum frame to a non-local one. The relativistic Doppler shift is shown to be independent of this stepping process, but the relativistic effects on space and time measurements is dependent upon this process. By applying these concepts, the twin paradox and stellar aberration can be explained.

Staroverov A.  
SPACE IS THE ANTIPODE OF MATTER

A concept by which space is the antipode of matter is considered. Existing of multidimensional and pseudo-spaces is proved to be impossible, which is to say that the theory of superstring is inconsistent.

Sukhorukov G., Sukhoreskov V., Sukhorukov R.  
ESTABLISHING OF UNIFIED LAWS FOR ATOMS AND THE UNIVERSE  
ON THE BASIS OF NEWTON'S IDEAS OF SPACE AND TIME

Formulas of unified laws for mechanical and light waves were derived. In the context of entrained ether experiments by Fizeau, Michelson, Sagnac and aberration phenomenon were explained. General rules of interacting

РОССИЙСКАЯ АКАДЕМИЯ НАУК  
НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ИНСТИТУТ  
РАДИОЭЛЕКТРОННЫХ КОМПЛЕКСОВ

---

Проблемы исследования Вселенной  
Выпуск 17

# РАЗВИТИЕ КЛАССИЧЕСКИХ МЕТОДОВ ИССЛЕДОВАНИЯ В ЕСТЕСТВОЗНАНИИ

САНКТ-ПЕТЕРБУРГ  
1994

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*Craig Spaniol (WVSC) and John F. Sutton (NASA-GSFC)*  
«G»

This paper describes a derivation of an algebraic relationship between the Newtonian gravitational constant ( $G$ ) and other experimentally determined physical constants. The technique involves an electrical circuit approach and includes the principles of resonance, power, energy, action, and Doppler frequency shift. The calculated numerical result is in agreement with the currently accepted (CODATA) mean value at the 11 ppm level of precision which is an order of magnitude greater than the listed level of precision (128 ppm).

### Background

Over the past several years, a model of the electron has been developed that appears promising in the ability to understand and calculate particle masses [1, 2, 3]. One of the interesting direct results was the algebraic relationship presented in this paper. This model, named HYDRA, includes gravitational energy and represents the mass system as an electrical circuit. It was initially developed as a method of estimating natural frequencies that may appear in the upper ionosphere due to electron excitation. It has been developed into a detailed model of electron structure and has been partially extended into general lepton structure. This paper focus on what is termed the zero order or non-rotational equations. The higher order section of the model deals with magnetic and inertial properties. As time and funding permit, work will continue on this most interesting subject.

### Hydra Model

The methods employed and present state of model development are described in the three referenced **Physics Essays** journal articles on this subject. Relativistic Doppler, quantum (resonance) and electrical circuit concepts are the central theme of the HYDRA model development. All physical properties are reduced to electrical circuit equivalent representations and result in circulating

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electric currents associated with their respective resonant circuit. For example, the electrical, gravitational, and spin systems are uniquely defined by individual currents and frequencies. The fundamental assumptions or hypotheses associated with the HYDRA model are:

1. Gravitational energy is not excluded. Electric, magnetic and gravitational field interactions are not included directly. They are implicit within the current frequencies.

2. Both the electric and gravitation systems are modeled as coupled resonant circuits with associated power, energy and action values. Cross-flow power is an integral part of the model.

3. Currents are defined by  $ef$ . Frequencies are defined by  $V\lambda$ . Frequency shifts due to velocity frame differences are defined by the relativistic Doppler shift. Frequencies are referenced to the electron's rest frame (zero linear velocity).

4. The electron is modeled with radial (zero order) and azimuthal (higher order) motion (frequency).

5. Quantum concepts are included. Action ( $h$ ), energy ( $hf$ ) and power ( $hff$ ) are assumed to be quantized. Electron spin action is assumed to be  $h/2$ .

These currents are similar to the generalized Dirac current ( $j^\mu$ ) which is an integral component of the classical relativistic Lorentz—Dirac equation for a charged particle. This classical Dirac approach was extended by others to include a self-field interaction term generated with quantum field concepts. The identification of the radiation reaction term with the anomalous magnetic moment interaction is implicit in quantum field theory. A cross-field coupling term was developed which interlocks self-energy with an anomalous magnetic moment (Pauli) interaction. The end result is that the radiation reaction term in the classical relativistic Lorentz—Dirac equation ( $2\alpha/3$ ) can be recalculated with QED principles to produce the more correct value of  $\alpha/2\pi$ . The HYDRA approach does not address such interactions directly. However, any such interactions will manifest as small frequency shifts or deviations in the HYDRA derived currents ( $I = ef$ ). In other words, the QED corrections to the electron magnetic moment anomaly will appear as a small correction to the Doppler shifted HYDRA frequencies. This frequency correction is derived from the experimental value for the moment anomaly. Because the experimental anomaly value and the QED derived value are identical, one could use the QED value to find the HYDRA currents and the results would also be identical. Since HYDRA cur-

rents are directly related to electron mass, both HYDRA and QED derived corrections can be represented as small mass variations.

The basic zero order (radial) HYDRA equation simply states the algebraic relationship that must hold between electron mass, gravitation constant, magnetic moment anomaly,  $h$ ,  $\alpha$ , and electron charge. The physical process (such as virtual particle charge shielding) that produces the magnetic moment anomaly is not necessary to identify within the HYDRA development as such effects enter the model in the form of an input experimental value. Therefore they are included within the relativistic Doppler effect. While the HYDRA model is a simple approach, its initial contribution to science is that it includes gravitational effects (G), which are  $10^{40}$  times less than electrical, and demonstrates that they are directly related through the electron's spin (cross-coupling) system. The resultant zero order equation yields an algebraic relationship between G and other experimentally determined physical constants. The Newtonian gravitation constant is an integral component of the HYDRA model which cannot exist without it. For example,  $f_2$  (gravitational current frequency) can be calculated without G in terms of  $\alpha$ ,  $h$ , and  $c$  without producing any new knowledge. But by calculating  $f_2$  in terms of the gravitational self-energy or gravitation constant (G), the two independent simultaneous equations for  $f_2$  produce new knowledge in the form of an algebraic relationship between G,  $\alpha$ ,  $h$ , and  $e$ . This is the heart of the HYDRA development and G cannot be neglected without nullifying the entire concept.

The zero order equations can be produced or summarized by the following approach where the magnetic moment is represented as a relativistic Doppler shift.

$$\mu_B = eh/(4\pi m_e) \quad (1)$$

and

$$\mu_e = eh/(4\pi m_e') \quad (2)$$

so that

$$\mu_e / \mu_B = m_e / m_e' \quad (3)$$

Since

$$m_e = hf_e / c^2 \quad (4)$$

and

$$m_e' = hf_e' / c^2 \quad (5)$$

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then

$$\mu_e \mu_B = f_e / f_e \quad (6)$$

or

$$[\mu_e / \mu_B] f_e = c \quad (7)$$

Therefore the quantity  $\mu_e \mu_B$  may be interpreted as a Doppler frequency shift factor with associated velocity frame difference of KC or

$$\mu_e \mu_B = [\{1 + (Kc/c)\} / \{1 - (Kc/c)\}]^{1/2} \quad (8)$$

The calculated radial velocity of the electron is derived in the journal articles and is simply the ratio of the classical electron radius divided by the Compton wavelength or

$$V = [r_e \lambda_C] c = [\alpha/2\pi] c \quad (9)$$

Therefore, in the first approximation,

$$K = V/c = \alpha/2\pi \quad (10)$$

and

$$\mu_e \mu_B \simeq [1 + (\alpha/2\pi)] / [1 - (\alpha/2\pi)^2]^{1/2} \simeq 1 + \alpha/2\pi \quad (11)$$

This result indicates that the approach is reasonable, but that  $K$  is not identically equal to  $\alpha/2\pi$ . The true value of  $K$  can be calculated directly from the  $\mu_e / \mu_B$  experimental value or from the QED corrected calculated value for  $\mu_e / \mu_B$  (these two values are identical) Either produces

$$K = 1.158\,979\,792 \cdot 10^{-3} \quad (12)$$

which results in a shifted frequency unit of

$$f_{uHz} = [(\alpha/2\pi)/K] [1 \text{ Hz}] = 1.002\,096\,671 \text{ Hz} \quad (13)$$

and proceed with the HYDRA development within the frequency shifted system. This value is in good agreement with the detailed HYDRA derivation at the ppb level of precision and QED effects are now implicit within  $f_{uHz}$  and the HYDRA model. The exact formulation of  $f_{uHz}$  is given by

$$[\mu_e / \mu_B - \mu_B / \mu_e] f_{uHz} = [\{(1 + \alpha/2\pi) / (1 - \alpha/2\pi)\}^{1/2} - \{(1 - \alpha/2\pi) / (1 + \alpha/2\pi)\}^{1/2}] 1 \text{ Hz} \quad (14)$$

or

$$f_{uH_z} = [(\alpha/2\pi)/K][1 \text{ Hz}][\{1 - K^2\}^{1/2}/\{1 - (\alpha/2\pi)^2\}^{1/2}] \quad (15)$$

which also yields at the 2 ppb level of precision

$$f_{uH_z} = 1.002\,096\,673 \text{ Hz.} \quad (16)$$

The basic timing or frequency unit of the electron is created within the azimuthal system. The azimuthal system must operate at the same base frequency as the radial system ( $c/\lambda_c$ ) which sets the azimuthal (tangential) velocity at  $\alpha c$ . The azimuthal motion, when projected on a fixed diameter, moves away from the center for a half cycle and toward the center for the other half. The base frequency or timing (since time is the inverse of frequency) unit is created by this motion through the relativistic Doppler shift or

$$f_u = \{(1 + \alpha)/(1 - \alpha)\}^{1/2} f_{uH_z} - \{(1 - \alpha)/(1 + \alpha)\}^{1/2} f_{uH_z} \quad (17)$$

and

$$f_u = 2\alpha f_{uH_z}/(1 - \alpha^2) = 2\alpha f_{uH_z} + \alpha^3 f_{uH_z} + \dots \quad (18)$$

where

$$f_{u0} = 2\alpha f_{uH_z} \quad (19)$$

$$f_{u1} = \alpha^3 f_{uH_z}. \quad (20)$$

This zero order frequency unit can be used to develop a quantum of cross-power from spin action or

$$P_X = \text{Aff} = [\hbar/2][2\alpha f_{uH_z}]^2. \quad (21)$$

HYDRA treats the electron at the zero order level as two coupled resonant circuits. These circuits contain self-energy ( $\hbar f_1$ ,  $\hbar f_2$ ) and a cross-power ( $P_X$ ) between them. The power equations for this circuit arrangement are

$$P_1 = I_1^2 Z_1 \quad (22)$$

$$P_2 = I_2^2 Z_2 \quad (23)$$

$$P_{12} = P_X = 2 I_1 I_2 Z_{12}. \quad (24)$$

Since the circuits are resonant, the impedances reduce to pure or free space resistances. For the closed circuit cross-power equation ( $I = ef$ ),

$$P_X = 2[ef_1][ef_2][(\mu_0/\epsilon_0)^{1/2}/(2\pi)]. \quad (25)$$

The value of  $f_1$  is the Compton frequency or

$$f_1 = c/\lambda_c = [m_e c^2]/h \quad (26)$$

and  $f_2$  is obtained from the gravitation self-energy or

$$f_2 = [m_e^2 G r_e]/h \quad (27)$$

The electron cross-power is then calculated as

$$P_x = 2[ec/h_c][e(m_e^2 G r_e)/h][(\mu_0/\epsilon_0)^{-1/2}/(2\pi)] \quad (28)$$

Setting the two equations for cross-power equal produces

$$2[(m_e^2 c^2 G)/(h^2 r_e)] = \alpha f_{uHz} \quad (29)$$

or

$$2[(m_e^2 c^2 G)/(h^2 r_e)] = \alpha[(\alpha/2\pi K)(1 \text{ Hz})]^2 \quad (30)$$

which yields the following relationship for G

$$G = [h^2 r_e \alpha^3 (1 \text{ Hz})^2]/[8m_e^3 \pi^2 c^2 K^2] \quad (31)$$

or

$$G = 6.672 \ 527 \ 5 \cdot 10^{-11} \text{ m}^3/\text{kg} \cdot \text{sec}^2 \quad (32)$$

The mathematics used to date are basic algebra and trigonometry. Spherical harmonic techniques following Schrodinger wave matrix algebra after the Heisenberg approach are anticipated as the next level of sophistication. Probably a review of Einstein's general relativity and an extension into tensor mathematics as well as non-Euclidean geometry will be required, but the work is in too early a stage to determine the highest level or appropriate applied methods. A principal method for determining validity of the HYDRA research will be the establishment of equivalence between the model results with currently accepted theories of gravity, nuclear, and atomic physics. Likewise, the work cannot become bogged down in any one area. QED calculations for the electron magnetic anomaly appear to be a life-long task. However, the application of the HYDRA model to a potential anomaly in the electron-position magnetic moment anomalies appears to be a very significant application. At present, there is no intention to expand the HYDRA results to cosmology, although someone will probably do this.

The experimental approach taken for this work is simple and straightforward. It involves the construction of a spherical model of the electron. It will resemble a spherical capacitor or resonant

cavity that will be excited at various frequencies to confirm the mass-coupling calculations of electron currents. This work will assemble earlier work done on waveguides and transmission lines. Such work was not done on spherical models since they are difficult to construct and have limited application to engineered communication systems. It is much easier and cost effective to build linear wave guides and cylindrical resonators than spherical ones. In fact, it was not until the middle of this century that theoretical calculations were developed for a spherical resonator by Schumann. He was interested in the earth-ionosphere cavity resonant frequencies and needed a theoretical model. Indeed, the principal cavity resonances are titled, "Schumann resonances". The mathematics is similar to the wave mechanics approach in quantum mechanics, but this work was never directly associated with the concept of a spherical resonator. It was a "normalized wave equation", and the electron was described as a fuzzy ball without structure. Electrical applications, such as microwave theory, had not been developed at that time; and there was no physical example to compare the quantum work with except the Bohr planetary model. Currently, there are no extensive experimental data available on spherical resonators. The instrumentation that will be employed will be modern off-the-shelf units, and the techniques will be similar to those used previously on linear or cylindrical waveguides.

The HYDRA model has produced an algebraic relationship between  $G$  and the other fundamental physical constants of nature. It holds the promise of producing other important physical relationships such as the direct calculation of particle masses. The present level of calculational accuracy is two orders of magnitude greater than the current level of precision given for the gravitational constant. High precision experimental data on the value of  $G$  are essential to the further development of HYDRA.

#### REFERENCES

1. "Classical Electron Mass and Fields I", Physics Essays, Volume 5, Number 1, March 1992, pp. 61-69.
2. "Classical Electron Mass and Fields II", Physics Essays, Volume 5, Number 3, September 1992, pp. 429-447.
3. "Classical Electron Mass and Fields III", Physics Essays, Volume 6, Number 2, June 1993, (pending).

**Positive Leadership: The Unfinished Agenda for Higher Education in the 21st. Century.** Dr. Griffin was co-founder of the BCA during his tenure in the Virginia Higher Educational System.

Sandra Maharaj, career counselor, has a book review for "Electronic Resume Revolution" by Joyce Lain Kennedy and Thomas J. Morrow printed in the Spring 1994 Journal of Career Planning and Employment.

Patricia D. Kline, director of career services, was elected secretary for the West Virginia College Placement Association at its spring conference. **CONGRATULATIONS!**

Steve W. Batson, vice president for planning and institutional advancement, presented a program on "Fund Raising for Nonprofit Organizations" to the Board of Directors of the Mental Health Association of Charleston on June 23.

**CONGRATULATIONS** to Louise Thornton, department of education. She recently became a certified professional secretary (CPS).

Dr. Craig Spaniol, professor, A.A.S. in electronics engineering technology and principal investigator of the NASA Project in the community college division, his wife Wanda and two sons, Michael and G.C., recently returned from St. Petersburg, Russia. Dr. Spaniol's presentation of a paper on special relativity at the International Conference on Space, Time and Gravitation was supported by the West Virginia State College research committee. Dr. Spaniol's paper, was one of several invited papers that addresses paradoxes associated with Einstein's 1905 formulation of the special theory of relativity. While Dr. Spaniol and Michael attended the relativity conference presentations, Wanda and G.C., who are employed at Thomas Memorial Hospital, visited medical facilities in the St. Petersburg area. G.C. is a graduate of the WVSC Community College Division's A.A.S. in Nuclear Medicine Technology program.

Dr. Spaniol and Dr. John Sutton, NASA technical officer, recently presented a paper at the joint annual meeting of the American Physical Society and the American Association of Physics Teachers in Crystal City, Virginia.

Kitty Frazier and Sandra Marshburn, associate professors of English, served as co-directors with Mark Defoe at a high school teachers' conference connected with the West Virginia Humanities Council's Circuit Writers Project. The conference, held June 19-24 at West Virginia Wesleyan College, involved teachers from across the state who worked to develop curriculum units to include the works of West Virginia authors in the high school curricula. Danny Boyd, communications, and Denise Giardina, English department, made presentations during the conference.

### Thank You...

Sincere appreciation to the West Virginia State College family for your expressions of love following the loss of our home on May 31. Your kindness will always be remembered.

John & Regina Powell and Family

### Name Change

The Career Planning and Placement Office has changed its name to **Career Services**. Career Services is located in Wallace Hall, Room 216 and will continue to provide services in the areas of career decision making, job search skills development, application to graduate/professional schools, standardized testing, job placement of federal college work study and job placement student labor (August, 1994).

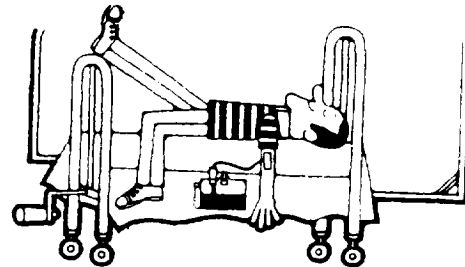
### Monthly Report

Barbara Harmon-Schamberger, secretary of education and the arts, has requested a report be sent to her on a monthly basis. The report is to be very brief. Information is to be in the following categories:

1. Congressional/Presidential Contacts;
2. Presidential Visits;
3. and 4. Scripts/PSA's with wording that reflects (Caperton) administration goals;
5. INSPIRE/TQM;
6. Growth/Decline;
- and 7. Employee Achievements.

Please send your information to John Hendrickson, Campus Box 193, on or before the 20th of each month.

(As an example, for the May report, we listed under Category 7, two employees as having earned master's degrees).



### Give a Pint - Save a Life

Accidents and illness never take a vacation. Blood supplies need to be replenished during the summer months. If you haven't donated blood for awhile or would like to be a first time donor, please call the **AMERICAN RED CROSS** at 346-0494.

A 3-day grant proposal writing workshop will be held July 25-27 at West Virginia State College. Tuition for the workshop is \$395.00 per person. For further information contact, Debra Martin, grant resource specialist at 766-3026.



# TRIPLET SOLUTION OF THE TWIN PARADOX

by

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## ABSTRACT

This paper investigates relativistic effects between inertial reference frames that are moving at different velocities. The focus is on measurement of space (distance) and time (intervals) within each inertial frame as well as relative to each other. The radar Doppler effect is applied to calculate total (down and return) frequency shift and to extrapolate a relativistic Doppler shift, length contraction and time dilation formulas. A preferred or zero reference frame concept is addressed in terms of total system momentum and each moving inertial frame velocity is referred to this zero total system momentum frame. Relativistic changes in space and time measurements within each inertial frame (metric) are calculated with velocities referenced to this defined zero reference frame. Space and time measurements between individual reference frames are calculated through the zero reference frame. This permits relativistic effects to be calculated in a stepwise manner from a local zero momentum frame to a non-local one. The relativistic Doppler shift is shown to be independent of this stepping process, but the relativistic effects on space and time measurements are explicitly dependent upon this process. By applying these concepts, the twin paradox and stellar aberration can be explained.

## Introduction

This paper does not significantly change any of the existing formulas or postulates of special relativity, which have existed for nearly a century. It does derive the existing equations, including the Lorentz-Einstein equations, and focuses on the explanation of apparent inconsistencies when these equations are applied to physical processes. In

addition to the existing two postulates,

Postulate 1: All inertial frames are equivalent with respect to all the laws of Physics.

Postulate 2: The speed of light in empty space always has the same value  $C$ .

we propose a third postulate:

Postulate 3: All kinematic calculations must be velocity referenced to the system's center of momentum velocity frame ( $V = 0$ ). All photon exchange processes are independent of velocity frame reference.

This third postulate will remove the arbitrary selection of a velocity reference frame.

The first step in this approach is to closely examine the acoustical (sonar) and electromagnetic (radar) Doppler effects. The two systems are similar in that source and receiver are in the same velocity reference frame and the effect is a result of sending a pulse down-range to a target and measuring the frequency of the return (echo) pulse. When one compares the sonar and radar Doppler shift formulas, they are identical as well as relativistically correct. Since the radar down-range and return Doppler

shift formulas must also be identical due to the symmetry of the photon exchange processes. This leads directly to the conclusion that the one-way Doppler shift is the square root of the radar or sonar Doppler shift.

The next step is to separate the one-way Doppler shift into two parts. The first factor is the geometrical effects or distortion between the velocity frame affecting the photon frequency. The second factor is the distortion of the space-time metric within the moving velocity frame that affects the photon frequency. The first (geometrical) factors for the radar process must produce the total (down and return) radar Doppler shift since the pulse may be modeled as simply reflecting off of the target and not participating in the target's metric distortion. The second (metric) set of factors must cancel in the radar process since the pulse may also be modeled as an absorption and re-radiation process which involves the metric distortions. In fact, the metric distortion factor  $\gamma$ , or  $1/(1 - \beta^2)^{1/2}$ , may be calculated by simply removing the geometrical factors from the individual down-range and echo Doppler shifts. Therefore, the two metric shift or distortion factors must be inversely related. The geometric factors are usually not.

Once the frame metric factor  $\gamma$  has been determined, there are only two possible metric equations,  $X = \gamma X'$  or  $X' = \gamma X$ .

The difference between the two is simply the interchange of moving and rest frame designation. This is the source of most inconsistencies when applied to relativistic problems such as the twin paradox. It is, of course, not possible to use both metrics simultaneously. If time dilates in one frame, it must contract in the other frame. Similarly, it is possible to develop the geometric space-time distortion equations between two velocity frames. As in the case of the metric equations, there are two sets which are identical except for the interchange of the reference and velocity frame designations. By properly substituting the metric equations into the geometric equations, one produces two sets of transformation equations. One is identical to the Lorentz-Einstein equations and the other is simply the interchange of the reference and velocity frame designations. These equations are valid for the total transformation from one velocity frame to another. The next step is the selection of the correct equation set which is the same as choosing the reference velocity frame or choosing the correct metric. The correct metric equation is  $X' = X/\gamma$  or that length and time contract within any velocity frame referred to the reference frame. This eliminates one set of total transformation equations and results in the standard set of Lorentz-Einstein equations.

It is very important to note that the metric transformation **cannot** be obtained directly from the Lorentz-Einstein

equations by simply setting  $t_x = t'_x = 0$ . This produces an inconsistent set of equations or  $X = \gamma X'$  and  $X' = \gamma X$ . This is simply not possible. If time or a time interval is set to zero in both frames, the proper interpretation is that the two measurements are being made in the same velocity frame. In such a case  $\gamma = 1$  and the Lorentz-Einstein equations produce  $X' = X$  and  $X = X'$ , which is acceptable. The same is also true for time, where a distance or distance interval is set to zero in both velocity frames.

For physical processes involving masses as opposed to photons, the selection of a velocity reference frame directly affects the calculational results. Photon exchange processes are unaffected by velocity reference frame selection. Whenever masses and velocities are involved, momentum becomes a part of the system. Therefore, the selection of a velocity frame reference directly affects any momentum associated with the masses. When a velocity frame selection is made, it should be properly designated as a momentum or inertial frame not simply a velocity frame. For a specific system of masses moving at different velocities, the selection of a velocity reference frame is actually the selection of the total momentum of the mass system. If one requires that the velocity reference frame ( $V = 0$ ) be selected such that the total mass system momentum is also zero in this frame, then this selection process is no longer

arbitrary. There can only be one reference velocity and that must be where total system momentum is also zero. This velocity reference frame is designated the "Center of Momentum" (COM) velocity reference frame. This is also the minimum mass velocity frame in that if all system particles collide, the resultant rest velocity would be the COM velocity frame and the total mass of the system would be the sum of the rest mass of each individual object. Total system mass cannot be reduced to a lower value by changing the designated reference frame. Selection of any other reference frame would only increase the total system mass.

Thus the development of the COM concept has removed the ambiguity of reference frame and metric selection for relativistic calculations. For a system with one large mass and several very small masses, the momentum of the large mass will dominate the total system momentum. Therefore the large mass rests in the system COM. Since most laboratories are located on the surface of the earth and experiment with very small particles moving with high velocities, the earth forces the laboratory to be the system COM reference frame. Therefore, all moving particle masses are greater than their rest masses, and their lifetimes are longer than when they are at rest (as measured in the laboratory). The system metric requires that this occur. However, within the moving particles velocity frame, particles on the earth have shorter lifetimes and reduced

mass. Similarly, a measured length within the moving particle frame is smaller (along all three axes) than when at rest in the laboratory. Dimensions in the laboratory are much larger than dimensions in the moving particle frame. These statements are about what changes in length, mass and time actually occur. The Lorentz-Einstein equations describe what "appears to occur" if one uses light pulses to measure space-time dimensions between different velocity frames. They correctly describe the combined distortions of space-time and mass due to real (metric) and "apparent" geometric distortions. If one correctly removes any relativistic geometric distortion from the Lorentz-Einstein equations, then the real space-time metric would remain.

Solution to the twin paradox now becomes simple since there is now only one allowable metric. The reference velocity frame is now the frame where total system momentum is zero. A simple example would be if the earth were the only planet in the universe, it would be the center of momentum reference frame for all its occupants. Any astronauts leaving the earth would experience time dilation since they would be leaving and returning to the center of momentum reference frame. If two astronauts left the earth in opposite radial directions with the same magnitude of velocity, following identical flight plans and returned to earth, the two astronauts would not experience any age discrepancy between themselves. However, both would find

that the ground crew that remained on earth all aged more than they have. In fact, the ground crew is aged precisely by a factor of  $\gamma$  greater than the astronauts. An actual interstellar voyage would require a very complex center of momentum calculation involving many large masses.

Similarly, if one accelerated the earth away from an astronaut and returned it to the original position, the ground crew would be older because they remained in the center of momentum frame throughout this process. Which mass accelerates does not determine which person ages faster. It is only which one remains in the center of momentum frame that matters.

Muons travelling at the same velocity in the laboratory will experience the same lifetime increase when measured in the laboratory. The muons will not detect any difference in the lifetimes of their sister particles travelling at the same velocity, even though they may be approaching each other at extremely high velocities. However, they will find that their sister muons at rest in the laboratory have very short lifetimes. Any system metric transformation must be linear and cannot produce inconsistencies such as the twin paradox.

The relativistic causes of the stellar aberration phenomenon are discussed by French in great detail<sup>4</sup>. The heart of the matter is that the Lorentz-Einstein equations show that



transverse lengths (or wavelengths) do not differ between velocity frames. However, since velocities (length per unit time) are also dependent upon the time metric that they are measured, transverse velocities are a direct function of  $\gamma$ . This conclusion is consistent with French's derivation of the stellar aberration formula. The problem that occurred is that the aberration is a function of the earth's velocity with respect to the sun as opposed to the earth's velocity relative to the observed star. The star's velocity relative to the earth is determined by its optical Doppler shift which has been shown to be entirely independent of reference frame velocity. In addition, the aberration angle is found to be a function of the angle produced by a line between the star and the sun, not the earth and star. These two apparent discrepancies are explainable with the center of momentum reference frame concept. Obviously the sun is the local center of momentum for our solar system, just as the earth is the local center of momentum frame for laboratory experiments on earth. Therefore, relativistic phenomena such as stellar aberration must be calculated in a stepwise manner. This means that one must calculate the local aberration effect as a first step (aberration due to earth motion relative to the sun) and then calculate the aberration due to the sun's motion relative to the galaxy, etc. Star aberration due to the sun's motion is not detectable on earth. However, since the sun is the local center of momentum, the optical line for star aberration is

centered on the sun, not the earth. Star aberration, as measured on earth, does not produce the aberration angle for the earth-star optical line. One must use the earth's velocity to calculate the relativistic effect on a line drawn between the sun and the star. The solar zero momentum frame controls stellar aberration between the solar system and our galaxy while the earth's velocity controls the earth observed stellar aberration within the solar system.

In summary, this paper has demonstrated that a valid and consistent metric relationship can be developed for relativistic problems. The proper application of this metric requires that a "center of momentum" velocity reference frame be determined and designated the reference velocity frame. By applying these principles to the twin paradox problem, the paradox is removed. The twin who moves out of the COM frame ages less than his twin in the COM frame. Stellar aberration observed on earth is produced by the earth's velocity relative to the solar system COM - the sun. Doppler shifts are produced by the relative velocity between the source and observe, independent of the COM.

## 1. Doppler Effect

The frequency shift due to source and receiver being in different relative velocity frames is designated the Doppler shift. For acoustical waves, the frequency shift of an echo or return sound wave in a sonar system is given by<sup>1</sup>

$$f' = f[(1 + \beta_s)/(1 - \beta_s)] \quad (1)$$

where  $\beta_s = v/C_s$  for sonar and  $C_s$  is the speed of sound in the acoustical medium.  $v$  is the relative velocity between the sonar target and the sonar transducer. A positive  $v$  represents the case where the target and the transducer are closing on each other. A negative  $v$  means that the target is headed away from the sonar transducer. This relationship was developed entirely geometrically on the principle that sound has a fixed velocity in a particular medium. The same relationship should represent an electromagnetic radar pulse by simply changing the wave velocity to  $C$ , the speed of light. Therefore, the radar Doppler shift of an echo or return pulse should be and is given by

$$f' = f[(1 + \beta)/(1 - \beta)] \quad (2)$$

where  $\beta = v/C$  for radar and  $C$  is the speed of light in the electromagnetic medium (vacuum).  $v$  is the relative velocity between the radar antenna and the target object. This

equation was developed entirely on Mach's principle that the speed of a sound wave has a constant velocity in a medium, without regard for which velocity reference frame it is measured.

For the radar case, this presents an interesting situation in that the correct equation was derived without reference to the special theory of relativity. This result is understandable when one considers the fact that the radar pulse may simply reflect off of the target surface without being absorbed into the target's frame of reference. Therefore it does not interact with the relativistic distortions of the target's space-time metric. Any relativistic metric distortions in the radar's reference frame are cancelled when the emitted pulse returns to the radar's velocity reference frame. Likewise, any distortions in space-time geometry between the two velocity frames must produce the radar Doppler shift. Since it is also possible to model the radar process with the pulse being absorbed by the target and re-radiated, the space-time metric distortions within the radar and target velocity frames must cancel or must be inversely related. Therefore, metric (frame to frame) transformations must be linear.

With these thoughts in mind, the outward (down-range) and return (echo) pulse frequencies can be derived. Since the exchange of photons between velocity frames is independent of velocity frame reference ( $v = 0$ ), the down-range and echo

pulse Doppler shifts should be identical. Therefore, the total radar Doppler shift is given by the square of either the down-range or echo pulse Doppler shift. In other words, the outward and return pulse frequency shift is given by

$$f' = f[(1 + \beta)/(1 - \beta)]^{1/2}. \quad (3)$$

This is the relativistically correct Doppler shift formula for both the downrange pulse to the target and the echo pulse received by the radar equipment. It was developed on the principle that the pulse reflection model and the pulse absorption/reflection model must yield the same results for the total radar Doppler shift and that the downrange Doppler shift must be identical to the return pulse shift. The symmetry of the photon exchange process between the radar system and target also demands that these two Doppler shifts must be equal. Electromagnetic or photon exchange between two velocity frames of reference is completely independent of velocity frame reference ( $v = 0$ ) as long as velocities are added or combined by Fitzeau's formula<sup>2</sup>

$$V_t = (V_1 + V_2)/(1 + V_1 V_2 / c^2). \quad (4)$$

In fact, Fitzeau's formula may be derived by simply requiring that the Doppler shift between two velocity frames, including an absorption and re-radiation process in another velocity reference frame, be identical with the

direct Doppler shift between source and receiver. Thus,

$$f' = f \{ [1 + \beta_1] / [1 - \beta_1] \}^{1/2} \{ [1 + \beta_2] / [1 - \beta_2] \}^{1/2} \quad (5)$$

and

$$f' = f \{ [1 + \beta_e] / [1 - \beta_e] \}^{1/2} \quad (6)$$

which, when equated, yields the Fitzeau velocity addition formula.

The down-range sonar Doppler effect is given by

$$f' = f(1 + \beta_s) \quad (7)$$

and the echo by

$$f' = f / (1 - \beta_s) \quad (8)$$

which are not relativistically correct. However, it does represent the geometrical distortion of the space-time between the source and receiver. If the radar Doppler shift for photons is rewritten as

$$f' = f \{ \gamma(1 + \beta) \} \{ 1 / \gamma(1 - \beta) \} \quad (9)$$

where  $\gamma = 1 / (1 - \beta^2)$ , then the required metric distortion between velocity reference frames must be  $\gamma$ , for any relativistic calculations. Any metric distortion within a velocity frame must combine with the geometric distortion

between frames to produce the correct source to receiver (one-way) Doppler frequency shift.

By using similar arguments, the off-axis radar Doppler shift may be developed geometrically or

$$f'(\theta) = f(1 + \beta \cos \theta) / (1 - \beta \cos \theta) \quad (10)$$

and the corresponding one-way Doppler shift is given by

$$f'(\theta) = f[(1 + \beta \cos \theta) / (1 - \beta \cos \theta)]^{1/2}. \quad (11)$$

Once the frame metric factor ( $\gamma$ ) has been determined, it cannot become a function of  $\theta$  without creating a measurable distortion in the reference frame. Therefore,  $\gamma$  cannot be changed to  $1/[1 - \beta^2 \cos^2 \theta]^{1/2}$ . It must be the same for all space-time directions within a given velocity frame.

## 2. Relativistic Metrics

Any distortion in the flow of time or distances within a velocity reference system, as referenced to another velocity reference frame, must be linear or the frame will lose its equivalence with other frames of reference. Since the radar Doppler effect yielded the value of the relativistic metric,

$\gamma$ , there are only two available metrics. If the  $X$  frame of reference is designated the unaffected reference frame where  $X = X$  and the  $X'$  frame is distorted,  $X' = \gamma X$ , then  $X'$ , in the undistorted metric frame given by

$$X' = X \quad t'_X = t_X \quad (12)$$

$$Y' = Y \quad t'_Y = t_Y$$

$$Z' = Z \quad t'_Z = t_Z$$

must be replaced with  $\gamma X$  as well as in all the metric or

$$X' = X/\gamma \quad t'_X = t_X/\gamma \quad (13)$$

$$Y' = Y/\gamma \quad t'_Y = t_Y/\gamma$$

$$Z' = Z/\gamma \quad t'_Z = t_Z/\gamma.$$

If the  $X'$  frame of reference is designated the unaffected reference frame where  $X' = X'$  and the  $X$  frame is distorted,  $X = \gamma X$ , then  $X$  in the undistorted metric frame must be replaced with  $\gamma X$ , as well as in all of this second metric,

$$X' = \gamma X \quad t'_X = \gamma t_X \quad (14)$$

$$Y' = \gamma Y \quad t'_Y = \gamma t_Y$$



$$Z' = \gamma Z \quad t'_Z = \gamma t_Z.$$

The time components along each axis have been included explicitly because geometric distortions affect time differently along different axes.

### 3. Relativistic Geometrics

The geometric effect of the  $X'$  axis moving with a positive (closing) velocity along the  $X$  axis is simply  $X' = X - Vt_X$ . The transverse axes ( $Y$  and  $Z$ ) are more complex, but derived in detail elsewhere. The complete equation set for the  $X$  frame as the zero velocity reference frame is

$$X' = X - Vt_X \quad X = \gamma^2(X' + Vt'_X) \quad (15)$$

$$Y' = Y/\gamma \quad Y = \gamma Y'$$

$$Z' = Z/\gamma \quad Z = \gamma Z'$$

$$t'_X = t_X - VX/C^2 \quad t_X = \gamma^2(t'_X + VX'/C^2)$$

$$t'_Y = t_Y/\gamma \quad t_Y = \gamma t'_Y$$

$$t'_Z = t_Z/\gamma \quad t_Z = \gamma t'_Z.$$

A similar set of equations exists for the  $X'$  frame as the reference frame

$$X = X' - Vt'_{xx} \quad X' = \gamma^2(X + Vt_{xx}) \quad (16)$$

$$Y = Y'/\gamma \quad Y' = \gamma Y$$

$$Z = Z'/\gamma \quad Z' = \gamma Z$$

$$t_x = t'_x - VX'/c^2 \quad t'_x = \gamma^2(t_x + VX/c^2)$$

$$t_y = t'_y/\gamma \quad t'_y = \gamma t_y$$

$$t_z = t'_z/\gamma \quad t'_z = \gamma t'_z$$

These two geometric transformations describe the relativistic effects on the geometry between two velocity frames, explicitly defining the reference frame for each.

### 3. Combined Metric and Geometric

There are two possible metric and two possible geometric transforms. It is necessary to match the correct metric and geometric transforms in order to produce the correct Doppler shift formulas. For the first set of geometric transforms, one must use the metric where  $X' = X'$  and  $X$  is replaced with

$\gamma X$  or

$$X' = \gamma(X - Vt_x) \quad X = \gamma(X' + Vt'_x) \quad (17)$$

$$Y' = Y \quad Y = Y'$$

$$Z' = Z \quad Z = Z'$$

$$t'_x = \gamma(t_x - VX/C^2) \quad t_x = \gamma(t'_x + VX'/C^2)$$

$$t'_y = t_y \quad t_y = t'_y$$

$$t'_z = t_z \quad t_z = t'_z.$$

This is one version of the Lorentz-Einstein transformation equations where the frame distortion metric is  $X' = \gamma X$  and  $X'$  is the reference or  $V = 0$  frame.

For the second set of geometric transforms, one must use the metric where  $X = X$  and  $X'$  is replaced with  $\gamma X'$  or

$$X = \gamma(X' - Vt'_x) \quad X' = \gamma(X + Vt_x) \quad (18)$$

$$Y = Y' \quad Y' = Y$$

$$Z = Z' \quad Z' = Z$$

$$t_x = \gamma(t'_x - VX'/c^2) \quad t'_x = \gamma(t_x + VX/c^2)$$

$$t_y = t'_y \quad t'_y = t_y$$

$$t_z = t'_z \quad t'_z = t_z$$

This is the second version of the Lorentz-Einstein transformation equations where the frame distortion metric is  $X = \gamma X'$  and  $X$  is the reference frame ( $V = 0$ ).

Both sets will produce correct results, but an ambiguity in the metric transform is a problem. Which metric does one choose? Once chosen it should not be arbitrarily changed throughout a calculation. It is identical to the question as to which velocity frame is the reference ( $V = 0$ ) frame. Note that the frame metric cannot be obtained by simply setting  $t_x = t'_x = 0$ . This produces an inconsistency in the transformation equations that cannot be permitted. The Lorentz-Einstein equations are a combination of metric and geometric transformations that requires careful consideration to disassemble or apply to physical problems.

#### 4. Center of Momentum Reference Frame

For physical processes involving masses as opposed to photons, the selection of a velocity reference frame

directly affects the calculational results. Photon exchange processes are unaffected by velocity reference frame selection. Whenever masses and velocities are involved, momentum becomes a part of the system. Therefore, the selection of a velocity frame reference directly affects any momentum associated with the masses. When a velocity frame selection is made, it should be properly designated as a momentum or inertial frame not simply a velocity frame. For a specific system of masses moving at different velocities, the selection of a velocity reference frame is actually the selection of the total momentum of the mass system. If one requires that the velocity reference frame ( $V = 0$ ) be selected such that the total mass system momentum is also zero in this frame, then this selection process is no longer arbitrary. There can only be one reference velocity and that must be where total system momentum is also zero. This velocity reference frame is designated the "Center of Momentum" (COM) velocity reference frame. This is also the minimum mass velocity frame in that if all system particles collide, the resultant rest velocity would be the COM velocity frame and the total mass of the system would be the sum of the rest mass of each individual object. Total system mass cannot be reduced to a lower value by changing the designated reference frame. Selection of any other reference frame would only increase the total system mass.

Selection of the velocity reference frame also results in

the selection of a relativistic metric. If  $m_0$  is the rest mass of a particle in the COM frame, then then the mass in any other frame is given by  $m' = \gamma m_0$  or that time and length contract such that  $t' = t_0/\gamma$  ( $E = mc^2 = hf = h/t = hc/\lambda$ ). Thus the metric for the COM frame calculations is

$$X' = X/\gamma \quad t'_x = t_x/\gamma \quad (19)$$

$$Y' = Y/\gamma \quad t'_y = t_y/\gamma$$

$$Z' = Z/\gamma \quad t'_z = t_z/\gamma.$$

The corresponding set of transformation equations (Lorentz-Einstein) is given by

$$X = \gamma(X' - Vt'_x) \quad X' = \gamma(X + Vt_x) \quad (20)$$

$$Y = Y' \quad Y' = Y$$

$$Z = Z' \quad Z' = Z$$

$$t_x = \gamma(t'_x - VX'/c^2) \quad t'_x = \gamma(t_x + VX/c^2)$$

$$t_y = t'_y \quad t'_y = t_y$$

$$t_z = t'_z \quad t'_z = t_z.$$

This is the second version of the Lorentz-Einstein transformation equations where the frame distortion metric is  $X = \gamma X'$  and  $X$  is the reference frame ( $V = 0$ ).

Thus the development of the COM concept has removed the ambiguity of reference frame and metric selection for relativistic calculations. For a system with one large mass and several very small masses, the momentum of the large mass will dominate the total system momentum. Therefore the large mass rests in the system COM. Since most laboratories are located on the surface of the earth and experiment with very small particles moving with high velocities, the earth forces the laboratory to be the system COM reference frame. Therefore, all moving particle masses are greater than their rest masses, and their lifetimes are longer than when they are at rest (as measured in the laboratory). The system metric requires that this occur. However, within the moving particles velocity frame, particles on the earth have shorter lifetimes and reduced mass. Similarly, a measured length within the moving particle frame is smaller (along all three axes) than when at rest in the laboratory. Dimensions in the laboratory are much larger than dimensions in the moving particle frame. These statements are about what changes in length, mass and time actually occur. The Lorentz-Einstein equations describe what "appears to occur" if one uses light pulses to measure space-time dimensions between different velocity

frames. They correctly describe the combined distortions of space-time and mass due to real (metric) and "apparent" geometric distortions. If one correctly removes any relativistic geometric distortion from the Lorentz-Einstein equations, then the real space-time metric would remain.

For a two mass system, velocity  $\beta$  values can be calculated by the following formula which requires that the total relativistic momentum be zero.

$$m_1\beta_1/(1 - \beta_1^2)^{1/2} = m_2\beta_2/(1 - \beta_2^2)^{1/2} \quad (21)$$

$$\beta_T = (\beta_1 + \beta_2)/(1 + \beta_1\beta_2)$$

$$\beta_1 = (\beta_T - \beta_2)/(1 - \beta_T\beta_2)$$

$$\beta_2 = (\beta_T - \beta_1)/(1 - \beta_T\beta_1)$$

$$\beta_1 = \beta_T/[1 + (m_1/m_2)(1 - \beta_T^2)^{1/2}]$$

$$\beta_2 = \beta_T/[1 + (m_2/m_1)(1 - \beta_T^2)^{1/2}]$$

## 5. Twin Paradox

Solution to the twin paradox now becomes simple since there is now only one allowable metric. The reference velocity



frame is now the frame where total system momentum is zero. A simple example would be if the earth were the only planet in the universe, it would be the center of momentum reference frame for all its occupants. Any astronauts leaving the earth would experience time dilation since they would be leaving and returning to the center of momentum reference frame. If two astronauts left the earth in opposite radial directions with the same magnitude of velocity, following identical flight plans and returned to earth, the two astronauts would not experience any age discrepancy between themselves. However, both would find that the ground crew that remained on earth all aged more than they have. In fact, the ground crew is aged precisely by a factor of  $\gamma$  greater than the astronauts. An actual interstellar voyage would require a very complex center of momentum calculation involving many large masses.

Similarly, if one accelerated the earth away from an astronaut and returned it to the original position, the ground crew would be older because they remained in the center of momentum frame throughout this process. Which mass accelerates does not determine which person ages faster. It is only which one remains in the center of momentum frame that matters.

Muons travelling at the same velocity in the laboratory will experience the same lifetime increase when measured in the

laboratory. The muons will not detect any difference in the lifetimes of their sister particles travelling at the same velocity, even though they may be approaching each other at extremely high velocities. However, they will find that their sister muons at rest in the laboratory have very short lifetimes. Any system metric transformation must be linear and cannot produce inconsistencies such as the twin paradox.

## 6. Stellar Aberration

The relativistic causes of the stellar aberration phenomenon are discussed by French in great detail<sup>4</sup>. The heart of the matter is that the Lorentz-Einstein equations show that transverse lengths (or wavelengths) do not differ between velocity frames. However, since velocities (length per unit time) are also dependent upon the time metric that they are measured, transverse velocities are a direct function of  $\gamma$ . This conclusion is consistent with French's derivation of the stellar aberration formula. The problem that occurred is that the aberration is a function of the earth's velocity with respect to the sun as opposed to the earth's velocity relative to the observed star. The star's velocity relative to the earth is determined by its optical Doppler shift which has been shown to be entirely independent of reference frame velocity. In addition, the aberration angle is found to be a function of the angle produced by a line between the

star and the sun, not the earth and star. These two apparent discrepancies are explainable with the center of momentum reference frame concept. Obviously the sun is the local center of momentum for our solar system, just as the earth is the local center of momentum frame for laboratory experiments on earth. Therefore, relativistic phenomena such as stellar aberration must be calculated in a stepwise manner. This means that one must calculate the local aberration effect as a first step (aberration due to earth motion relative to the sun) and then calculate the aberration due to the sun's motion relative to the galaxy, etc. Star aberration due to the sun's motion is not detectable on earth. However, since the sun is the local center of momentum, the optical line for star aberration is centered on the sun, not the earth. Star aberration, as measured on earth, does not produce the aberration angle for the earth-star optical line. One must use the earth's velocity to calculate the relativistic effect on a line drawn between the sun and the star. The solar zero momentum frame controls stellar aberration between the solar system and our galaxy while the earth's velocity controls the earth observed stellar aberration within the solar system.

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## ***APPENDIX D***

### ***PUBLICATIONS***

***Classical Electron Mass & Fields, Part III***

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**CLASSICAL  
ELECTRON MASS  
AND FIELDS,  
PART III**

**Craig Spaniol and John F. Sutton**

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# Classical Electron Mass and Fields, Part III

Craig Spaniol and John F. Sutton

## Abstract

*This paper continues a development of the HYDRA model. A spherical shell physical model concept is introduced. The Rydberg and Hartree reference frames are explained. The full cross-coupling matrix is developed, and modulation concepts are discussed. Future research areas and potential applications are included.*

**Key words:** electron, mass, gravitation constant, HYDRA, lepton, intrinsic spin, SS particle, self-energy, atomic spectra, Lamb shift

## 1. INTRODUCTION

This paper concludes the development of the HYDRA model and associated fundamental relationships. The first two papers<sup>1,2</sup> presented HYDRA as an electrical resonance model of the electron. It would be more appropriate to describe it as an electrical resonance model of free space that treats mass and electrical properties as manifestations of the same phenomena, using electrical currents, resonance, power, energy, and action as the defining parameters. The electron fits this model perfectly, because it is the fundamental of fundamental particles, since it exists (resonates) in the free space structure by precisely matching the resonance structure of free space.

The model was initially developed as an infinitely thin spherical charge shell with a radius equal to the self-energy average of the electron charge. This paper develops a physical, thick shell model. The two are mathematically equivalent, since the thick shell model collapses to the thin shell representation when the volumetric charge distribution is replaced with an energy equivalent surface charge distribution (Gauss's law).

In addition, the model further collapses to a thin ring (line) charge distribution when Stokes's theorem is applied. HYDRA was used to develop the concept of an atomic electron with associated atomic spectra, shells, and Sommerfeld fine-structure energy formula.

The nuclear electron was extended to develop gravitational coupling constants, which are directly related to fundamental and nuclear particle masses that occupy these cross-coupling resonances. A geometric unit diagram was developed for the electron, and when applied to the positron, it produces a reasonable estimate for existing experimental data on magnetic moment anomaly differences for these two particles. The field structure produced by the HYDRA currents has not been addressed, but is an important area of future research along with its spherical (geometric) and electrical phase properties.

## 2. THICK SHELL MODEL

The thin shell model was developed with radial oscillation as an abstract concept characterized by the defined frequency of  $C/\lambda_c$  and a charge velocity (energy averaged) of  $\alpha C/2\pi$ . This sets the radial distance of travel at  $r_e$ , the classical radius of the electron. If radial oscillation forces the charge to zero radius, the electric field self-energy and charge density go infinite. This is the same problem a point charge concept encounters. Therefore, we must determine the location or minimum and maximum radii of the oscillating charge distribution while maintaining the correct average energy and charge travel distance. In other words, the difference between  $r_{\max}$  and  $r_{\min}$  must equal  $r_e$ , and the self-energy averaged distance must equal  $r_e$ . Therefore,

$$\int_{R_{\min}}^{R_{\max}} [e^2/(4\pi\epsilon_0 R)] dR / \int_{R_{\min}}^{R_{\max}} dR = e^2/4\pi\epsilon_0 r_e \quad (1)$$

and

$$\ln(R_{\max}/R_{\min}) = 1, \quad (2)$$

or

$$R_{\max}/R_{\min} = e^1 = 2.718281828 \dots \quad (3)$$

also

$$R_{\max} - R_{\min} = r_e. \quad (4)$$

These equations can be developed by other approaches, such as creating a spherical capacitor with capacitance equal to that of the thin shell model. It should be noted that both the radial and azimuthal capacitances as well as the inductances for any representation have the values of

$$C_{\text{radial}} = C_{\text{azimuthal}} = 2\pi r_e \epsilon_0 \quad (5)$$

$$I_{\text{radial}} = I_{\text{azimuthal}} = 2\pi r_e \mu_0 \quad (6)$$

regardless of whether they are one-, two-, or three-dimensional models. There is no distinction between self-inductance or self-capacitance as long as the energies calculated for these models are identical. For example, there is no distinction made between the capacitance of an isolated sphere (self-capacitance) and its equivalent spherical representation with the same capacitance. Thus the azimuthal and radial electrical properties are identical; however, the physical radial distance is  $r_e$  while the azimuthal distance is  $2\pi r_e$ . This is rather obvious, since radial velocity is  $\alpha C/2\pi$ , while tangential velocity is  $\alpha C$ , but they have the same characteristic frequency. In fact, this requirement alone (azimuthal electrical characteristics must equal radial) would force the electron into a spherical shell configuration. The inner and outer radius values for the electron are

$$r_{\text{max}} = r_e/(1 - e^{-1}) = 4.457\,916\,90 \times 10^{-15} \text{ m} \quad (7)$$

$$r_e = 2.817\,940\,92 \times 10^{-15} \text{ m} \quad (0.13 \text{ ppm}) \quad (8)$$

$$r_{\text{min}} = r_e/(e^1 - 1) = 1.639\,975\,98 \times 10^{-15} \text{ m} \quad (9)$$

Similarly, the atomic electron radii values (taken in the Hartree energy frame) would be

$$r_{\text{max}} = r_{\text{ac}}/(1 - e^{-1}) = 0.837\,146\,082 \times 10^{-10} \text{ m} \quad (10)$$

$$r_{\text{ac}} = a_0 = 0.529\,177\,249 \times 10^{-10} \text{ m} \quad (0.045 \text{ ppm}) \quad (11)$$

$$r_{\text{min}} = r_{\text{ac}}/(e^1 - 1) = 0.307\,968\,833 \times 10^{-10} \text{ m} \quad (12)$$

The fact that the natural logarithmic constant appears explicitly in the atomic electron structure could explain why it appears so frequently in natural macroscopic phenomena.

The Hartree energy frame is the one that was previously identified as the annihilation frame, and total energy is given by

$$E_i = m_e C^2(1 - \alpha^2)^{1/2} + m_e \alpha^2 C^2/(1 - \alpha^2)^{1/2} \quad (13)$$

where the first term is identified as rest mass energy, and the second is kinetic energy. The Hartree energy is derived from the first term of the kinetic energy expansion or

$$E_H = \alpha^2 m_e C^2 \quad (14)$$

The Rydberg energy frame is given by

$$E_i = m_e C^2/(1 - \alpha^2)^{1/2} = m_e C^2 + (1/2)\alpha^2 m_e C^2 + \dots \quad (15)$$

and the Rydberg energy is identified by the second term in the expansion. The first term is rest mass energy. Both frames are equivalent representations of the electron structure as was previously shown. The velocity frame invariant is the same for both of these expansions and total energy is conserved. Both frames were critical in the development of the Sommerfeld energy formula. Essentially, the two different frames of reference can be physically identified through the azimuthal angle ( $\theta$ ) and its associated zero or reference radial axis. In the laboratory frame this reference axis is locked onto the laboratory frame axis and has zero angular velocity. Therefore, the radial oscillating mass (or mass energy) has an angular velocity of  $\alpha C/r_e$  or a tangential velocity of  $\alpha C$ . Therefore, the measured rest mass ( $m_e$ ) is associated with the Rydberg frame, and the expansion given in Eq. (15) accurately represents this view or frame of reference.

The Hartree frame of reference is associated with the zero azimuthal reference axis and the radial oscillating mass locked (azimuthally) on the laboratory frame reference axis. In this representation the radial oscillation of the rest mass has no tangential velocity, or exhibits its true rest mass. Therefore, the rest mass (zero order) value of  $m_e(1 - \alpha^2)^{1/2}$  is the correct value.

Now the rotating kinetic energy appears to have a mass value of  $\alpha^2 m_e$  with associated higher order terms or  $\alpha^2 m_e/(1 - \alpha^2)^{1/2}$ . This is the physical basis of the Hartree frame as given by Eq. (13), and both the Hartree and Rydberg views are relativistically consistent.

In the early development of the HYDRA model, it was proposed that the energy contained within the links should be doubled due to current flow up and down the ladder links. This was necessary in order to account for total magnetic (kinetic) energy manifesting as twice the single link flow. We now feel that the flow is not up and down each side, but rather flows up one side and down the other. Therefore, the link energy should not be doubled.

The fact that the magnetic energy calculation yields twice the expected value is due to the Hartree energy frame representation. In other words, the HYDRA model should be developed independently in these two energy reference frames with two different rest masses. The resultant magnetic field energies will differ by a factor of 2, but the rest masses will be nearly (parts per million) the same. This is also why the neutrino energy could take on two different values (Rydberg or Hartree) during the annihilation process.

The atomic electron manifests its Hartree frame (boson-orbit motion  $l$  values 0, 1, 2, ...) characteristics when orbit angular momentum is measured, but exhibits Rydberg frame characteristics when spin (fermion) effects are encountered. This phenomenon is also apparent when the atomic electron exhibits both  $e/m_e$  and  $e/2m_e$  properties. It is most noticeably present in the Sommerfeld fine-structure energy formula.



Now that the electron current is identified as oscillating in a spherical shell cavity, it is appropriate to invoke some of the principles associated with transmission line and cavity resonance theory. First of all, a traveling wave should exhibit three characteristic velocities – group, phase, and wave. The wave velocity should always be  $C$ , in a free space medium, and the product of phase and group velocity must equal  $C^2$ . This sets group and phase velocities as inverse quantities. The radial current should exhibit the velocities of  $\alpha C$ ,  $2\pi/C$ , and  $2\pi C/\alpha$ . Similarly, the azimuthal wave will contain the velocities of  $\alpha C$ ,  $C$ , and  $C/\alpha$ . These velocities are the source of physical quantities associated with the electron and electrical phenomena. For example, the radial action, per cycle, is given by

$$Et = (e^2/4\pi\epsilon_0 r_c)[r_c(\alpha C/2\pi)] = h, \quad (16)$$

which is also a statement of Heisenberg's uncertainty principle, since a cycle must be completed before a value can be produced. Or, explicitly in terms of radial variation  $\Delta r$ ,

$$\Delta E \Delta t = (e^2/2\pi\epsilon_0 \Delta r)[\Delta r(\alpha C/2\pi)] = h. \quad (17)$$

In fact, if one required that the radial action be  $h$ , then one can work Eq. (16) backwards and deduce many of the derived radial quantities. Mechanically the same radial action value is produced using the inverse velocity  $2\pi C/\alpha$  or

$$PX = m_e(2\pi C/\alpha)r_c = h. \quad (18)$$

This demonstrates that the radial electrical system operates with an action value of  $h$  as opposed to the azimuthal system which will be shown to exhibit a characteristic value of  $\hbar/2$ . The radial inductance can be calculated, but since it is a spherical charge distribution, a real magnetic field cannot form. This is probably why the electron is forced to rotate so that magnetic field energy can exist. The azimuthal magnetic field forms from the same inductance value, since both radial and azimuthal inductance is given by  $2\pi r_c \mu_0$ . Or, an explicit derivation is given as

$$c = q^2/2E = e^2/2E = e^2/[2(e^2/4\pi\epsilon_0 r_c)] = 2\pi\epsilon_0 r_c, \quad (19)$$

and since current is equal to  $V/R$ ,

$$l = 2E/I^2 = 2ER^2/V^2 = R^2 c = (\mu_0/\epsilon_0)c = 2\pi\mu_0 r_c. \quad (20)$$

Or, from the geometric definition of capacitance,

$$c = \epsilon_0 A/L, \quad (21)$$

where  $L$  is radial length, and  $A$  is surface (spherical) area,

$$c = \epsilon_0(\int \int \int r \sin\theta \, d\theta d\phi dr)/\int dr = 2\pi\epsilon_0 r_c, \quad (22)$$

and the same formula form applies to radial inductance. These derivations firmly establish the electrical and physical radial properties of the thick shell model. It should be noted that the electron is a slow wave oscillator in that the physically manifested frequency is  $(\alpha C/2\pi)/r_c$  as opposed to  $C/r_c$ , even though the velocity  $C$  is present in the system. The atomic electron is the converse in that it exhibits fast wave oscillation properties, and the azimuthal properties manifest in the Hartree energy reference frame.

The azimuthal system with three tangential velocities sets up the inertial mass or magnetic system. If we calculate inductive energy with the radius value varying and also allow the azimuthal frequency to vary while holding tangential velocity ( $\alpha C$ ) constant (Hartree frame), then the average inductive energy is given by

$$E_l = \int [(1/2)2\pi\mu_0 r[(e\alpha C)/(2\pi r)]^2 dr] / \int dr = \alpha^2 m_e C^2. \quad (23)$$

If one holds the angular frequency constant (Rydberg frame) and allows tangential velocity to vary, then  $\alpha C/2\pi r$  is constant and does not become part of the integration, or

$$E_l = \int [(1/2)2\pi\mu_0 r[(e\alpha C)/(2\pi r_c)]^2 dr] / \int dr = \alpha^2 m_e C^2/2. \quad (24)$$

Now to calculate azimuthal action values, we must integrate the energy over the azimuthal distance, which is  $2\pi r_c$  as opposed to  $r_c$ , which was appropriate when dealing with the total system energy viewed radially. For the Rydberg system, this yields an average energy value of

$$E_l = \alpha^2 m_e C^2/4\pi, \quad (25)$$

which produces an azimuthal action value per cycle of

$$A = Et = (\alpha^2 m_e C^2/4\pi)[(2\pi r_c)/(\alpha C)] = \alpha^2(\hbar/2), \quad (26)$$

and the correct spin action value is obtained by using the total wave velocity of  $C$ , or

$$E_l = \int [(1/2)2\pi\mu_0 r[(eC)/(2\pi r_c)]^2 dr] / \int dr = m_e C^2/4\pi \quad (27)$$

and

$$A = Et = (m_e C^2/4\pi)[(2\pi r_c)/(\alpha C)] = \hbar/2, \quad (28)$$

which is the correct azimuthal per cycle intrinsic spin action value, and again the Heisenberg uncertainty principle is reconstructed for the azimuthal action uncertainty (Hartree frame) as

$$\Delta E \Delta t = [(1/2)2\pi\mu_0 \Delta r[(eC)/(2\pi \Delta r)]^2][2\pi \Delta r/(\alpha C)] = h. \quad (29)$$

Dynamically the azimuthal action can take on two values, and for the Hartree frame with an inverse velocity of  $C/\alpha$ .

$$mvr = m_e(C/\alpha)r_e = \hbar, \quad (30)$$

where the Hartree mass appears twice as large as the dynamic mass for the Rydberg frame, and the azimuthal momentum appears as spin action in the Rydberg energy frame as

$$mvr = (1/2)m_e(C/\alpha)r_e = \hbar/2. \quad (31)$$

The magnetic moment is also produced with the inverse velocity as follows:

$$\mu_e = IA = e/\pi r_e^2 = e[(C/\alpha)/2\pi r_e]\pi(\alpha\lambda_e/2\pi)^2 = e\hbar/4\pi m_e. \quad (32)$$

Note that the moments and momentum values produced by the inverse velocities are not energies and can manifest physically without producing any real energy. The three tangential wave velocities play an important role in the development of physical values for the electron, as well as the two energy frame representations.

The natural resonant frequency of this system is interesting to investigate and is given for both radial and azimuthal systems as

$$f_r = 1/[2\pi(lc)^{-1}] = C/(2\pi)2r_e = C/(2\pi\alpha\lambda_e), \quad (33)$$

which shows that the fast wave velocity is necessary to sustain the natural oscillation frequency of the system. The  $2\pi$  discrepancy was discussed earlier, and the  $C/\alpha$  value is recognized as the azimuthal fast wave velocity. If one replaces  $C/\alpha$  in the resonance equation with the radial fast wave velocity of  $2\pi C/\alpha$ , the radial resonance becomes

$$f_r = (C/\alpha)/\lambda_e, \quad (34)$$

which supports the concept of the open-to-closed-system transfer function value of  $2\pi$ . For the radial system the fast wave concept introduces the possibility that it may extend out to a radius of  $2\pi\lambda_e/\alpha$ , since

$$vt = (2\pi C/\alpha)[r_e/(\alpha C/2\pi)] = 2\pi\lambda_e/\alpha = a_0, \quad (35)$$

which would permit direct fast wave interaction between the nucleus and atomic structure and could explain the extremely large atomic capture cross section for excited atoms. It also shows the close structural relationship between the atomic and nuclear electron states. Similarly, the total radial wave, velocity  $C$ , may extend to a distance of  $\lambda_e$ .

Classical kinetic energy matches the Rydberg frame value for the magnetic field energy as

$$E_{ke} = (1/2)m_e v^2 = (1/2)m_e(\alpha C)^2 = (1/2)\alpha^2 m_e C^2, \quad (36)$$

which is as expected, since rest mass energy appears in the laboratory and Rydberg energy reference frames as  $m_e$ .

### 3. ELECTRO-GRAVITATION COUPLING CONSTANTS

In this development of the nuclear electron, extensive use is made of the gravitation quantization action constant, which was derived as

$$\hbar_g = m_e^2(2\alpha\epsilon_e C) = m_e^2 2\pi G(\alpha C), \quad (37)$$

yielding the relationship of  $\alpha$  and  $\hbar_g$  as

$$\alpha = m_e G \hbar_g C, \quad (38)$$

and if we simply replace  $\hbar_g$  with  $\hbar$ , the coupling constant

$$\alpha_{gmc} = m_e^2 G \hbar C \quad (39)$$

is produced, which is the basic electrogravitation coupling constant as derived in the second paper and should be the basic cross-coupling unit exhibited by the electron in the HYDRA model.

Now one can calculate the per unit cross coupled power in the electron by defining the quantized crosspower as

$$P_x = 2\hbar f_r f_g = 2\hbar_g f_r f_g, \quad (40)$$

since

$$\hbar f_g = \hbar_g f_g, \quad (41)$$

and propose some quantum unit frequency  $f_x$  that produces a quantum of cross power defined as  $\hbar f_x^2$  so that the coupling is the quantized power ratio or

$$\alpha_{gmc} = P_x/\hbar f_x^2 = 2\hbar_g f_r f_g/\hbar f_x^2 = m_e^2 G/\hbar C. \quad (42)$$

This does not help much unless one knows  $f_x$ , but this equation can be solved for  $f_g$  in terms of  $f_r$  or

$$f_g = (\alpha\lambda_e/2C)f_r^2. \quad (43)$$

Obviously,  $f_x$  is  $f_{uHz}$  and this equation is an entirely independent derivation of the critical  $f_g$  relationship. Now the unit cross-coupling matrix can be calculated by determining the quantized energy that may flow between terms in the unit frequency expansion produced by the HYDRA model. The matrix elements are defined by

$$\alpha_{gmn} = (\hbar_g f_{gm})/(\hbar f_{en}) = C_{mn} \alpha_{gmc}, \quad (44)$$

and the masses produced by the crosscoupling are given by

$$M_{mn} = (C_{mn})^{1/2}. \quad (45)$$

The unit electrical frequencies were defined by

$$f_{eu} = [2\alpha(f_{uHz}/1 \text{ Hz})Hz]/[1 - (\alpha(f_{uHz}/1 \text{ Hz}))^2]^{1/2}, \quad (46)$$

or

$$f_{g1} = 2\alpha(f_{uHz}/1 \text{ Hz})\text{Hz}, \quad (47)$$

$$f_{g2} = [\alpha(f_{uHz}/1 \text{ Hz})]^2\text{Hz}, \quad (48)$$

$$f_{g3} = (3/4)[\alpha(f_{uHz}/1 \text{ Hz})]^3\text{Hz}, \quad (49)$$

$$f_{g4} = (5/8)[\alpha(f_{uHz}/1 \text{ Hz})]^4\text{Hz}, \quad (50)$$

and the gravitation frequency expansion is given by

$$f_{gu} = [2\alpha(1 \text{ Hz}/f_{uHz})\text{Hz}] [1 - [\alpha(1 \text{ Hz}/f_{uHz})]^2], \quad (51)$$

or

$$f_{g1} = 2\alpha(1 \text{ Hz}/f_{uHz})\text{Hz}, \quad (52)$$

$$f_{g2} = [\alpha(1 \text{ Hz}/f_{uHz})]^2\text{Hz}, \quad (53)$$

$$f_{g3} = (3/4)[\alpha(1 \text{ Hz}/f_{uHz})]^3\text{Hz}, \quad (54)$$

$$f_{g4} = (5/8)[\alpha(1 \text{ Hz}/f_{uHz})]^4\text{Hz}. \quad (55)$$

This representation of the unit frequencies with  $f_{uHz}$  explicitly included is necessary in order for the proper coupling term to be produced for the zero-order coefficient, or the following equation must hold for the  $m$  and  $n$  equal zero term:

$$P_{uHz} \alpha_{g0e0} = [(2h_g f_C f_C)/[h(1 \text{ Hz})^2]] \alpha_{g0e0} = \alpha_{gme}, \quad (56)$$

This relationship must hold in order for the coefficients to give the correct relationship for the mass ratio, since the coefficient ratio is the allowed cross-coupled power referenced to the electron cross-coupled power and correctly results in an electron mass ratio when the square root of the coupling constant is taken. The unit energy cross-coupling formula is then

$$\alpha_{gmen} = (h_g f_{gm})/(h f_{en}) = (M_{mn}/m_e)^2 [(m_e^2 G)/(\hbar C)]. \quad (57)$$

The coupling matrix terms, through  $m$  and  $n$ , equal 3 and are:

$$\begin{aligned} C_{00} &= 1/\alpha(f_{uHz}/1 \text{ Hz})^2, & C_{10} &= \alpha/2(f_{uHz}/1 \text{ Hz})^4; \\ C_{20} &= 3\alpha^3/8(f_{uHz}/1 \text{ Hz})^6, & C_{30} &= 5\alpha^5/16(f_{uHz}/1 \text{ Hz})^8; \\ C_{01} &= 2/\alpha^3(f_{uHz}/1 \text{ Hz})^4, & C_{11} &= 1/\alpha(f_{uHz}/1 \text{ Hz})^6; \\ C_{21} &= 3\alpha/4(f_{uHz}/1 \text{ Hz})^8, & C_{31} &= 5\alpha^3/8(f_{uHz}/1 \text{ Hz})^{10}; \\ C_{02} &= 8/3\alpha^5(f_{uHz}/1 \text{ Hz})^6, & C_{12} &= 4/3\alpha^3(f_{uHz}/1 \text{ Hz})^8; \\ C_{22} &= 1/\alpha(f_{uHz}/1 \text{ Hz})^{10}, & C_{32} &= 5\alpha/6(f_{uHz}/1 \text{ Hz})^{12}; \end{aligned} \quad (58)$$

$$C_{40} = 16/5\alpha^7(f_{uHz}/1 \text{ Hz})^{10}, \quad C_{13} = 8/5\alpha^5(f_{uHz}/1 \text{ Hz})^{12};$$

$$C_{23} = 6/5\alpha^3(f_{uHz}/1 \text{ Hz})^{12}, \quad C_{33} = 1/\alpha(f_{uHz}/1 \text{ Hz})^{14}.$$

There is an infinite number of allowed states, but these low-order states should produce the fundamental mass resonances. In fact, the only direct nucleon resonances predicted are the proton and neutron values derived from the  $C_{02}$  constant, which yields the gravitation coefficient as

$$\alpha_{gme} = C_{02} \alpha_{gme} = (m_p/m_e)^2 (m_e^2 G/\hbar C) \quad (59)$$

and is accurate to 400 ppm. Dropping one frequency unit down produces the neutron mass at 70 ppm. If one permits mixing of the coupling states, other fundamental resonances can be created. Half-integer values of the masses should exist, and inverse constants should be permitted, since

$$(C_{nn} C_{n+1, n+1})/(C_{n+1, n} C_{n+1, n}) = 1. \quad (60)$$

Self-mixing or the square of the mass ratio (which is the coefficient value) could occur. For example, the  $C_{00}$  value produces the charged  $\pi$  mesons by simply doubling it or

$$2C_{00} m_e = 2m_e/[\alpha(f_{uHz}/1 \text{ Hz})^2], \quad (61)$$

which is accurate to about 700 ppm, and the neutral  $\pi$  meson is also given at the 700 ppm value by

$$2C_{44} m_e = 2m_e/[\alpha(f_{uHz}/1 \text{ Hz})^{18}]. \quad (62)$$

Mixing of the  $\alpha^3$  states produces the tau particle mass as

$$(C_{01}/C_{12})M_{01} = (3/2)[2(f_{uHz}/1 \text{ Hz})^4/\alpha^3]^{1/2} m_e, \quad (63)$$

and the muon mass falls in at one frequency unit off from

$$(C_{01}/C_{12})C_{00} m_e = (3/2)[(f_{uHz}/1 \text{ Hz})^2/\alpha] m_e, \quad (64)$$

but seems to set at one unit higher, or

$$m_\mu = (3/2)[(f_{uHz}/1 \text{ Hz})^3/\alpha] m_e = 206.8 m_e \quad (65)$$

and is accurate at the 400 ppm level. The electroweak coupling (which is actually stronger than the nucleon coupling) occurs at the  $\alpha^5$  level, and the Z boson mass (91.5 GeV) is derived by

$$(1/2)(C_{02})^{1/2} m_e = 91.15 \text{ GeV}, \quad (66)$$

while the W boson mass (80.1 GeV) forms from

$$(C_{13}/C_{02})(C_{13})^{1/2} m_e = 83.7 \text{ GeV}. \quad (67)$$

Much more detailed work is necessary to properly interpret this coupling matrix, but the fact that it clearly produces the gravitation coupling constant is most significant. The coupling appears to form up in general levels as follows:

electric-gravitation (electron)	$(1/\alpha)\alpha_{gme}$	$1.75 \times 10^{-45}$
light quarks?	$(1/\alpha)\alpha_{gme}$	$2.40 \times 10^{-45}$
mesons, photon, muon	$(1/\alpha)^2\alpha_{gme}$	$3.29 \times 10^{-45}$
nucleons, tau, strong	$(1/\alpha)^3\alpha_{gme}$	$4.50 \times 10^{-49}$
excited states?	$(1/\alpha)^4\alpha_{gme}$	$6.17 \times 10^{-47}$
Z, W, electroweak, Fermi	$(1/\alpha)^5\alpha_{gme}$	$8.46 \times 10^{-45}$
heavy mass coupling	$(1/\alpha)^6\alpha_{gme}$	$1.16 \times 10^{-42}$

(68)

The Fermi coupling constant ( $G_F$ ) is not really a coupling constant, but is the mass of a coupling produced resonance. In this representation the actual Fermi coupling constant derived from the Fermi mass, which is  $(1/G_F)^{1/2}$ , would be

$$K_F = [(1/G_F)^{1/2}/m_e]^2 \alpha_{gme} = 5.75 \times 10^{-34} \quad (69)$$

and compares with four times the  $\alpha_{g1e3}$  coefficient or

$$4\alpha_{g1e3} = 4[8/[5\alpha^5(\int_{uHz}/1 \text{ Hz})^{10}]]\alpha_{gme} = 5.30 \times 10^{-34} \quad (70)$$

at the 8% level of precision. Recall that the Z boson mass was derived from 1/4 the  $\alpha_{g0e2}$  coupling constant. The Fermi constant is the result of a complex nucleon interaction, and an isolated Fermi mass particle has not yet been observed. The Z and W bosons are presently identified as the particles directly associated with electroweak coupling and the HYDRA coupling, matrix produces mass values in close agreement with these measured values. However, as more detail is produced with an actual nucleon cross-coupling model, including quark structure, the Fermi coupling constant may appear as a natural consequence. Nevertheless, the HYDRA coupling matrix produces reasonable results.

#### 4. MUON SYSTEM

Since specific data are currently available for the muon, one should be able to discuss the muon system in some detail without developing a complete HYDRA model for it. Basically, it should be possible to calculate the muon mass and moment in terms of electron magnetic moment anomaly data. It is interesting that this approach assumes or requires that elementary if not all particles must exhibit a magnetic moment anomaly. If we did not know that the muon moment anomaly existed, HYDRA would predict one and certainly predicts one for the tau particle. The Taylor and Cohen<sup>(3)</sup> values used for this development are

$$m_\mu/m_e = 206.768262 \pm 0.15 \text{ ppm}, \quad (71)$$

$$a_\mu = 1.1659230 \times 10^{-4} \pm 7.2 \text{ ppm}, \quad (72)$$

$$a_\mu = 1.15965193 \times 10^{-4} \pm 0.0086 \text{ ppm}, \quad (73)$$

$$(\mu_\mu/\mu_B - \mu_B/\mu_\mu) = 2.317961150 \times 10^{-5} \pm 0.0086 \text{ ppm}, \quad (74)$$

$$\alpha = 7.29735308 \times 10^{-3} \pm 0.045 \text{ ppm} \quad (75)$$

The basic frequency shift is taken from Eq. (A32) in our first paper,<sup>1</sup> and is given by

$$\Delta f_i = (\mu_\mu/\mu_B)(f_1 - f_2), \quad (76)$$

where we use the magnetic moment ratio for the muon to produce

$$(\mu_\mu/\mu_{B\mu})\Delta f = \Delta f', \quad (77)$$

But  $\mu_\mu/\mu_{B\mu}$  must be placed in the correct (Hartree) relativistic frame by modifying both mass and moment within this ratio, or

$$\mu_\mu/\mu_{B\mu} = (\mu_\mu/4\pi m_\mu)/(eh), \quad (78)$$

which means that both mass and moment can be corrected by

$$\begin{aligned} (\mu_\mu/\mu_{B\mu})' &= (4\pi/eh)(\mu_\mu/[1 - (\alpha/2\pi)^2])^{1/2} \{m_\mu/[1 - (\alpha/2\pi)^2]^{1/2}\} \\ &= (\mu_\mu/\mu_{B\mu})/[1 - (\alpha/2\pi)^2], \end{aligned} \quad (79)$$

or

$$(\mu_\mu/\mu_{B\mu})'[1 - (\alpha/2\pi)^2] = \mu_\mu/\mu_{B\mu}, \quad (80)$$

and the frequency deviation for  $f$  is set as

$$(\mu_\mu/\mu_{B\mu})'\Delta f = (\mu_\mu/\mu_{B\mu})\Delta f_i \quad (81)$$

and

$$\Delta f_i = \Delta f/[1 - (\alpha/2\pi)^2]; \quad (82)$$

also

$$\Delta f_i' = (\mu_\mu/\mu_{B\mu})\Delta f_i \quad (83)$$

and the Hertz frequency is given by

$$\Delta Hz = \Delta f_i' - \Delta f_i = a_\mu \Delta f_i, \quad (84)$$

$$\Delta f_i = \Delta f/[1 - (\alpha/2\pi)^2] = \Delta Hz/a_\mu, \quad (85)$$

$$\Delta f = \Delta Hz[1 - (\alpha/2\pi)^2]/a_\mu, \quad (86)$$

$$\Delta f = (\alpha/\pi) \text{Hz} [1 - (\alpha/2\pi)^2] / (a_\mu [1 - (\alpha/2\pi)^2]^{1/2})$$

$$= (\alpha/\pi) \text{Hz} [1 - (\alpha/2\pi)^2]^{1/2} / a_\mu \quad (87)$$

The muon unit frequency is created by

$$f_{\mu\mu} = (\Delta f / f_{\text{Hz}}) 1 \text{ Hz} \quad (88)$$

or

$$f_{\mu\mu} = [(\mu_\mu / \mu_B - \mu_B / \mu_e) 1 \text{ Hz} [1 - (\alpha/2\pi)^2]] / a_\mu \quad (89)$$

Now this equation represents the development of the muon fundamental frequency unit in the Hartree energy reference frame or viewpoint; however, the muon fundamental frequency unit should be a valid number in either reference frame, just as total energy is conserved between the two frames. Since the muon structure is built on top of the electron's or is its base and uses  $1/\alpha$  power coupling, the muon escalates the muon system mass by a value of  $1/\alpha$ . It is also attempting to reach the free space resonance coefficient value of  $N(1/2\alpha)^3$  or the action coefficient ( $N$ ) level of three. The basic resonance value for the muon is simply  $1/(\alpha f_{\text{uHz}\mu} 1 \text{ Hz})$ , but one should immediately escalate to the third level, as this is obviously where the muon operates. It is interesting that the third level continues to play an important role in elementary particle construction but the model is too crude, at this point, to explain why. The formula that predicts muon mass is then given by

$$m_\mu = 3 m_e / (\alpha f_{\text{uHz}\mu} / 1 \text{ Hz}), \quad (90)$$

which does not include in the  $f_{\text{uHz}\mu}$  calculation the fact that muon velocity is changing relative to the electron. This fact must be included or the frequency must be relativistically corrected, even though the formula is reasonable as it stands.

The velocity correction factor is derived by the following method. First, the numerator is built by removing the electron azimuthal ( $\alpha f_{\text{uHz}} C / 1 \text{ Hz}$ ) and radial ( $\alpha C / 2\pi$ ) velocity corrections by

$$K_\mu^2 = K_e^2 / K_{\mu\nu}^2 = [1 - (\alpha f_{\text{uHz}} / 1 \text{ Hz})^2] [1 - (\alpha/2\pi)^2] / K_{\mu\nu}^2, \quad (91)$$

and the denominator contains the muon azimuthal ( $\alpha C f_{\text{uHz}\mu} / 1 \text{ Hz}$ ) and radial ( $3\alpha C / 2\pi$ ) velocities or

$$K_\mu^2 = \frac{[1 - (\alpha f_{\text{uHz}} / 1 \text{ Hz})^2] [1 - (\alpha/2\pi)^2]}{[1 - (\alpha f_{\text{uHz}\mu} / 1 \text{ Hz})^2] [1 - (3\alpha/2\pi)^2]}. \quad (92)$$

When applied to the muon mass formula, this produces

$$m_\mu = 3 m_e / K_\mu (\alpha f_{\text{uHz}\mu} / 1 \text{ Hz}). \quad (93)$$

Now the muon system can be viewed in a different or the Rydberg energy reference frame by using information gleaned

from the HYDRA concept. One can then focus on the muon moment ratio and work with it directly.

First, the entire system should be corrected for the shift to radial velocity 3 as compared with the electron, or

$$\mu_\mu / \mu_{B\mu} = [\mu_\mu / \mu_B] [1 - (3\alpha/2\pi)^2]^{1/2} \quad (94)$$

$$\mu_\mu / \mu_{B\mu} = [1 + a_e] [1 - (3\alpha/2\pi)^2]^{1/2} \quad (95)$$

which is not a bad approximation as it stands, since it gives the correct value at 0.2 ppm. This is not highly accurate when  $a_\mu$  is considered and the comparison would be at the 166 ppm level of precision. A relativistic correction is required for  $a_e$ . The  $a_e$  represents the cross-flow power action, and since  $a_e$  is a magnetic moment value, the velocity coefficient ratio squared (as opposed to the coefficient ratio) should be used. The correction should be  $K_\mu^2$  instead of  $K_\mu$ . This sets the anomaly corrected formula as

$$\mu_\mu / \mu_{B\mu} = (1 + K_\mu^2 a_e) / [1 - (3\alpha/2\pi)^2]^{1/2} = 1 + a_\mu \quad (96)$$

Now Eqs. (89), (92), (93), and (96) describe the basic frequency structure relationships for the muon, and they are linearly independent. Equation (96) may be directly substituted into Eq. (89) in order to eliminate  $a_\mu$ , or

$$f_{\text{uHz}\mu} = \frac{[(\mu_e / \mu_B - \mu_B / \mu_e) 1 \text{ Hz} [1 - (\alpha/2\pi)^2] [1 - (3\alpha/2\pi)^2]^{1/2}]}{[1 + a_e K_\mu^2 - [1 - (3\alpha/2\pi)^2]^{1/2}]}. \quad (97)$$

This equation is most significant, since it gives the muon fundamental frequency in terms of the electron moment data only. These electron moment data are the most accurately known constants and should produce a high precision value for the muon frequency. Since the constant  $a_e$  dominates the overall precision level, Eq. (97) should be accurate to a level of 0.0086 ppm. Recalling that  $K_\mu$  is a function of  $f_{\text{uHz}\mu}$ , this equation can be solved by iteration, and the value below is iteratively accurate to a value of 0.5 ppb, or

$$f_{\text{uHz}\mu} = 1.988087001 \text{ Hz}. \quad (98)$$

This derived result indicates that the muon structure is striving for a  $2f_{\text{uHz}}$  level of operation. It would produce a unit structure identical with the electron, except that it would reduce the value of  $\alpha_e$  in the diagram to a value of about one-half that of the electron and similarly for the antimuon. This result produces a calculated velocity correction value of

$$K_\mu^2 = 1.000167826431933, \quad (99)$$

which, when inserted into Eq. (97) produces

$$f_{\text{uHz}\mu} = 1.988087001795 \text{ Hz} \quad (100)$$

and confirms the stated iteration precision. With this derived value for  $K_\mu^2$  and  $f_{\text{uHz}\mu}$ , the calculated muon mass is given by Eq. (93) as

$$m_\mu/m_e = 3 K_\mu^2 (\alpha f_{\text{uHz}\mu} / 1 \text{ Hz}) = 206.768\,353\,225 \quad (101)$$

and should be accurate at the precision level of  $\alpha$  or 0.045 ppm. It compares with experimental data<sup>41</sup> (206.768 262), which is stated to be 0.15 ppm, at the 0.44 ppm level of precision. Given the precision level of the calculation, one would predict that future experimental data will produce an experimental value closer to this calculated value. Nevertheless, the comparison is excellent as it stands. The muon magnetic moment anomaly can be calculated from either Eq. (89) or Eq. (96), and both give the following result:

$$a_\mu = 1.165\,923\,836\,21 \times 10^{-4} \quad (102)$$

they should be accurate to the precision level of  $a_e$  or 0.0086 ppm. This value compares with experimental data (1.165 923 0  $\times 10^{-4}$ ), which is stated to be accurate to 7 ppm, at the 0.7 ppm level. This comparison is also excellent and confirms the 923 figures given for the experimental value. One would certainly expect more precise data to corroborate the calculated value.

Whether the stated calculational precision is valid depends on precise data. If indeed the moment anomaly and the mass are directly related as HYDRA indicates, then the mass and moment interact to produce their final particle state values. These results certainly support the HYDRA model, and in fact one could not create the required equations without HYDRA-derived information on the muon structure. Nevertheless, this section strongly supports the HYDRA concept and the relationships derived for the electron or free space resonance structure.

## 5. TAU SYSTEM

The tau particle system may be developed in a manner similar to the muon system by examining how it forms on top of the muon structure with the mass defined by

$$m_\tau/m_e = 6/(\alpha f_{\text{uHz}\mu} K_\mu^2 / 1 \text{ Hz})[(a_e/a_\tau)\alpha f_{\text{uHz}\mu} K_\mu^2 / 1 \text{ Hz}]^{1/2}, \quad (103)$$

or

$$(m_\tau/m_e)^2 = 4(m_\mu/m_e)^3/[3(a_e/a_\tau)(K_\mu^3)], \quad (104)$$

where the system is operating at radial frequency 6, and the azimuthal system is operating at the square root level, but on top or extended from the muon structure as a base. Note that the velocity correction factor for the tau unit frequency is  $K_\mu^2$ , since it is functioning on a square root coupling, and it is correcting for the muon base velocity as opposed to the tau frequency. In other words, the tau mass formula must contain velocity correction or coupling at the power level

$3(K_\mu^2)$ . The velocity correction constant forms up for the tau particle as follows:

$$K_\tau^2 = \frac{[1 - (\alpha f_{\text{uHz}\tau} / 1 \text{ Hz})][1 - (6\alpha / 2\pi)^2]}{[1 - (\alpha f_{\text{uHz}\mu} / 1 \text{ Hz})][1 - (6\alpha / 2\pi)^2]} \quad (105)$$

The tau azimuthal velocity and the fundamental frequency unit are operating at the square root level. The fundamental frequency unit is defined for the tau particle identically as the muon unit, or

$$f_{\text{uHz}\tau} = [(\mu_e/\mu_B) - (\mu_B/\mu_e)][1 - (6\alpha / 2\pi)^2] a_e \text{ Hz} \quad (106)$$

The tau magnetic moment forms up for the sixth radial frequency level as

$$\mu_\tau/\mu_B = (1 + a_e K_\tau^2) [1 - (6\alpha / 2\pi)^2]^{1/2}, \quad (107)$$

and these four equations define the tau particle mass and magnetic moment system. As before, Eq. (107) may be substituted into Eq. (106) to determine the system parameters in terms of the electron moment data, or

$$f_{\text{uHz}\tau} = \frac{[(\mu_e/\mu_B) - (\mu_B/\mu_e)] 1 \text{ Hz} [1 - (6\alpha / 2\pi)^2][1 - (6\alpha / 2\pi)^2]^{1/2}}{[1 + a_e K_\tau^2 - [1 - (6\alpha / 2\pi)^2]^{1/2}]} \quad (108)$$

Again, the system frequency is defined in terms of the most precisely known constants of the electron, and should be accurate to the precision level of the fine-structure constant. Iterating Eq. (108) with Eq. (105) yields

$$f_{\text{uHz}\tau} = 1.930\,784\,501\,884 \text{ Hz} \quad (109)$$

with a value for  $K_\tau^2$  of

$$K_\tau^2 = 1.014\,284\,616\,409\,953 \quad (110)$$

and holds for an iteration accuracy of 1 ppb. This produces a magnetic moment anomaly value for the tau system as

$$a_\tau = 1.200\,526\,532\,91 \times 10^{-3}, \quad (111)$$

and mass

$$m_\tau/m_e = 3\,492.712 (1.784\,772 \text{ GeV}/m_e C^2), \quad (112)$$

which should be accurate at the 1 ppm level of precision and compares with experimental data<sup>42</sup> at the 400 ppm level [1.7841 (0.2%) GeV].

Once again, the HYDRA model has produced reasonable values for a lepton without developing a detailed structure. The leptons are simply walking up the free space coupling matrix in approximate steps of  $3N(1/2\alpha)^{(N+1)/2}$ , and the next lepton should be the SS particle. Why the  $N$  coefficient must

be a multiple of 3 cannot be determined at this level of development.

## 6. SS PARTICLE SYSTEM

This is definitely a most interesting particle system. It should be operating at a radial system frequency of 9. Since the base muon system operates at level 3, the SS particle can form as a double muon or a muon within a muon. It can double back on itself and produce the level 9 radial frequency with an apparent radial velocity the same as the electron. In fact, it does this. Therefore, the electron radial velocity ( $\alpha C/2\pi$ ) can "appear" to be the level 9 or double muon system. When the muon doubles back, if it does not increase its magnetic moment anomaly and its mass, it would become an electron. In essence, this would be a decay process. Therefore, it must drive its cross current flow (mass) up in order to survive (for a very short time) as an SS particle. In order to stabilize as a double muon system, it must produce a magnetic moment anomaly identically equal to the electron, or the SS particle anomaly must be

$$a_s = a_e = 1.159652193 \times 10^{-4}. \quad (113)$$

The SS particle mass is given by the following formula:

$$m_{ss}/m_e = 9/[(\alpha f_{uHz\mu} K_\mu^2/1 \text{ Hz})(\alpha f_{uHz\mu} K_\mu^2/1 \text{ Hz})], \quad (114)$$

where the unit frequency for the electron state is defined by

$$f_{uHz\mu} = [(\mu_e/\mu_B) - (\mu_B/\mu_e)][1 - (\alpha/2\pi)^2]/a_e \text{ Hz}. \quad (115)$$

This then sets the SS particle mass, in terms of the electron and muon parameters, as

$$m_{ss}/m_e = (m_\mu/m_e)^2/[(a_\mu/a_e)K_\mu^2], \quad (116)$$

which produces a mass value for the SS particle of

$$m_{ss}/m_e = 42516.042282654 (43.451 \text{ GeV}/m_e C^2 \text{ per pair}) \quad (117)$$

and compares with the CELLO collaboration data<sup>(2)</sup> (43.450 GeV/ $m_e C^2$  pair production value) at the 30 ppm level of precision. Hopefully, more precise experimental data will become available for the SS lepton.

## 7. SS2 PARTICLE SYSTEM

There is no reason to stop climbing the HYDRA ladder with the SS particle, although the energy and mass values are getting quite large. The SS2 particle should be another lepton operating with radial frequency 12. Its mass form is given by

$$m_{ss2}/m_e = 12/[(\alpha f_{uHz\mu} K_\mu^2/1 \text{ Hz})(\alpha f_{uHz\mu} K_\mu^2/1 \text{ Hz})] \\ \times 1/(\alpha f_{uHzs2} K_\mu^2/1 \text{ Hz})^{1/2}, \quad (118)$$

which is operating at coupling power level 5 ( $K^5$ ) and reduces to

$$(m_{ss2}/m_e) = 2^5(m_\mu/m_e)^2 [3^5(a_\mu/a_e)(K_\mu^2/K_\mu^2)(K_\mu^2)] \quad (119)$$

The only unknown quantity is the magnetic moment anomaly value for the SS2 particle ( $a_{ss2}$ ). This was not a problem with the SS particle, since it doubled back on top of the electron moment anomaly. However, one can calculate the SS2 anomaly the same as the other leptons by recalling that it operates at radial frequency level 12 and velocity couples at the eighth root of  $\alpha f_{uHzs2}$ . The SS2 defining equations are

$$\mu_{ss2}/\mu_{Bs2} = (1 + a_{ss2}K_{ss2}^2)[1 - (12\alpha/2\pi)^2]^{-1}, \quad (120)$$

$$f_{uHzs2} = [(\mu_e/\mu_B) - (\mu_B/\mu_e)][1 \text{ Hz}][1 - (\alpha/2\pi)^2]/a_{ss2}, \quad (121)$$

$$K_{ss2}^2 = \frac{[1 - (\alpha f_{uHzs2} 1 \text{ Hz})^2][1 - (\alpha/2\pi)^2]}{[1 - (\alpha f_{uHzs2} 1 \text{ Hz})^2][1 - (12\alpha/2\pi)^2]}. \quad (122)$$

Again, iterating for a solution yields the following values:

$$\mu_{ss2}/\mu_{Bs2} = 1.00178326497568 = 1 + a_{ss2}, \quad (123)$$

$$f_{uHzs2} = 1.299839370739 \text{ Hz}, \quad (124)$$

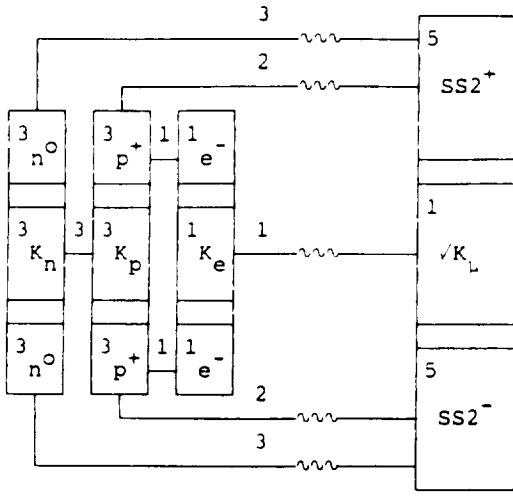
$$K_{ss2}^2 = 1.453856797639. \quad (125)$$

This produces the following value for the SS2 lepton mass:

$$m_{ss2} = 572980.171287 m_e = 292.792328926 \text{ GeV}/C^2, \quad (126)$$

which, not too surprisingly, is almost identical with the Fermi coupling constant expressed in mass units. The SS2 particle is operating at the same coupling level (5) as the Z and W bosons, which were identified as the mediating particles for the weak nuclear decay process. Obviously, the SS2 lepton is a better candidate, since it is a lepton and has the correct mass energy. The W and Z bosons are simply particles that are constructed from the same coupling level or are indeed weak nuclear coupled particles, but are not the mediator of neutron beta decay. The decay process is via virtual SS2 particles. When experimental data at the 300 GeV level become available, there certainly will be a particle produced at this energy.

The Fermi coupling energy is not necessarily a particle mass. In its raw experimental form, it is the energy squared of the decay coupling system. The neutron (a level 3 particle) decays via a pair of virtual SS2 leptons (level 5 particles) with the square root of a muon (level 2 particle) coupling constant that is necessary to couple the decay electron (level 1 particle). The SS2\* particle couples with the proton (level 3 particle) at level 2, since the decay electron couples with the proton at level 1. The neutron couples directly with the SS2



$$m_{SS2} C^2 (k_\mu)^{1/2} = 292.8046127 \quad \text{GeV}$$

$$\text{Total Process Energy} = 292.8046127 \quad \text{GeV}$$

Figure 1. Neutron weak decay process.

particle at level 3 (see Fig. 1). The total weak-decay process energy ( $E_j$ ) is simply the mass energy of the SS2 particle system coupled by the  $\sqrt{K_\mu}$  coupling constant. In the Fermi coupling constant form  $(1/mC^2)^2$ , the calculated value for the SS2 coupled weak-decay system constant is given by

$$G_F = 1/E_d^2 = 1/[m_{SS2}(K_\mu)^{1/2}]^2 C^4, \quad (127)$$

$$G_F = 1.166391032 \times 10^{-5} \text{ GeV}^{-2}, \quad (128)$$

and compares with experiment<sup>(40)</sup>  $[1.16639 \times 10^{-5} (17 \text{ ppm}) \text{ GeV}^{-2}]$  at the 1 ppm level of precision.

Several existing approaches, including the standard model of electroweak interactions,<sup>(41)</sup> predict the vector boson masses. While a resonance coupling matrix was developed with HYDRA, it should be considered as an approximate map of where mass resonances should occur. This work focuses on the development of lepton masses, since these particles should be the least complicated. HYDRA predicts the existence of a lepton with a mass approximately equal to the Fermi coupling mass, which is not currently predicted by the standard model. Some approaches permit the value of  $\alpha$  to become a function of energy with a value of  $1/128$  for a mass energy of about 80 GeV. HYDRA permits resonance jumps from one coupling level or state to another, but does not allow variations in  $\alpha$ . This is not meant to imply that the variable approach is not valid; it is simply an entirely different approach. When one approaches a physical problem from a non-Euclidean viewpoint,  $\pi$  may be altered to accommodate the new geometrical system. Such an approach is certainly valid, although somewhat complex.

## 8. VELOCITY FORMULAS

The velocity formulas used to calculate lepton masses were derived by equating each term of the following two frequency expansions:

$$\alpha f_{uHz} (1 - \alpha^2)^{1/2} = \alpha f_{uHz} + (\alpha^2/2) f_{uHz} + (3/8) \alpha^4 f_{uHz} + \dots (35/128) \alpha^6 f_{uHz} + \dots \quad (129)$$

$$(1 \text{ Hz}) [1 - (\alpha V/C)^2]^{1/2} = 1 \text{ Hz} + (\alpha^2/2) (V/C)^2 1 \text{ Hz} + (3/8) \alpha^4 (V/C)^4 1 \text{ Hz} + \dots (35/128) \alpha^6 (V/C)^6 1 \text{ Hz} + \dots \quad (130)$$

and the base calculational frequency is

$$f_{BHz} = 1 \text{ Hz}. \quad (131)$$

The velocities, developed by equating terms, are

$$\alpha f_{uHz} / f_{BHz} = (V_j/C) = \alpha f_{uHz} / 1 \text{ Hz} = \alpha f_{uHz} / 1 \text{ Hz}.$$

$$(V_1/C)^2 = \alpha f_{uHz1} / 1 \text{ Hz} = \alpha f_{uHz1} / 1 \text{ Hz}, \quad (132)$$

$$(V_2/C)^4 = \alpha f_{uHz2} / 1 \text{ Hz} = \alpha f_{uHz2} / 1 \text{ Hz},$$

$$(V_4/C)^8 = \alpha f_{uHz4} / 1 \text{ Hz} = \alpha f_{uHz4} / 1 \text{ Hz},$$

which sets the lepton velocities as

$$(V_\mu/C) = \alpha f_{uHz\mu} / 1 \text{ Hz},$$

$$(V_\tau/C) = (\alpha f_{uHz\tau} / 1 \text{ Hz})^{1/2}, \quad (133)$$

$$(V_{S1}/C) = (\alpha f_{uHzS1} / 1 \text{ Hz})^{1/4},$$

$$(V_{S2}/C) = (\alpha f_{uHzS2} / 1 \text{ Hz})^{1/8},$$

recalling that  $V_{S1}$  was not used due to the double muon effect, and the third-order term does not produce a muon.

## 9. INITIAL LEPTON MASS FORMS

The initial development of the lepton mass formulas came from multiple cross-flow terms. Each term must be referenced or divided by the common cross-flow frequency unit. The factor  $K_e$  represents the electron's velocity correction factor, which is nearly 1. These forms are as follows:

$$m_\mu = (3m_e) / [(\alpha f_{uHz\mu} / 1 \text{ Hz})(K_\mu K_e)]; \quad (134)$$

$$m_\tau = \frac{(6m_e) 1 / [(\alpha f_{uHz\tau} K_e / 1 \text{ Hz})(\alpha f_{uHz\mu} K_\mu / 1 \text{ Hz})]}{[(\alpha f_{uHz\tau} / 1 \text{ Hz})(K_e / K_\mu)]} \times \left( \frac{1 / [(\alpha f_{uHz\mu} K_\mu / 1 \text{ Hz})(\alpha f_{uHz\tau} K_\tau / 1 \text{ Hz})]}{[(\alpha f_{uHz\tau} / 1 \text{ Hz})(K_\tau / K_\mu)]} \right)^{1/2}; \quad (135)$$



$$m_{s_1} = \frac{(9m_e)1[(\alpha f_{uHze}K_e - 1 \text{ Hz})(\alpha f_{uHze}K_\mu - 1 \text{ Hz})]}{[(\alpha f_{uHze} - 1 \text{ Hz})(K_e - K_\mu)]} \\ \times \frac{1[(\alpha f_{uHze}K_\mu - 1 \text{ Hz})(\alpha f_{uHze}K_{s_1} - 1 \text{ Hz})]}{[(\alpha f_{uHze} - 1 \text{ Hz})(K_{s_1} - K_\mu)]}; \quad (136)$$

$$m_{s_2} = \frac{(12m_e)1[(\alpha f_{uHze}K_e - 1 \text{ Hz})(\alpha f_{uHze}K_\mu - 1 \text{ Hz})]}{[(\alpha f_{uHze} - 1 \text{ Hz})(K_e - K_\mu)]} \\ \times \frac{1[(\alpha f_{uHze}K_\mu - 1 \text{ Hz})(\alpha f_{uHze}K_{s_2} - 1 \text{ Hz})]}{[(\alpha f_{uHze} - 1 \text{ Hz})(K_\mu - K_{s_2})]} \\ \times \left( \frac{1[(\alpha f_{uHze}K_e - 1 \text{ Hz})(\alpha f_{uHze}K_{s_2} - 1 \text{ Hz})]}{[(\alpha f_{uHze} - 1 \text{ Hz})(K_{s_2} - K_e)]} \right)^{1/2}; \quad (137)$$

The electron velocity correction factor ( $K_e$ ) is not exactly 1. It should represent the Rydberg to Hartree frame shift necessary to bring the electron into the  $f_{uHze}$  equal to approximately the 2 level. This reference frame shift in the electron is accounted for in the following formula:

$$K_{eH}^2 = \frac{[1 - (\alpha f_{uHze}/1 \text{ Hz})^2][1 - [(\alpha f_{uHze}/\alpha f_{uHze})(\alpha/2\pi)]^2]}{[1 - (\alpha f_{uHze}/1 \text{ Hz})^2][1 - (\alpha/2\pi)^2]}; \quad (138)$$

$$K_{eH} = 1.000\,000\,504\,873\,79. \quad (139)$$

The electron's magnetic moment anomaly will be slightly perturbed in this state and is given for the Hartree reference frame by

$$a_{eH} = (1 + a_e k_{eH}^2)/[1 - [(\alpha f_{uHze}/\alpha f_{uHze})(\alpha/2\pi)]^2]^{1/2} - 1, \quad (140)$$

$$a_{eH} = 1.159\,823\,124 \times 10^{-3}, \quad (141)$$

and  $f_{uHze}$  is calculated as

$$f_{uHze} = [\mu_e/\mu_B - \mu_B/\mu_e]1 \text{ Hz}[1 - (\alpha/2\pi)^2]/a_{eH}, \quad (142)$$

$$f_{uHze} = 1.998\,544\,413 \text{ Hz}. \quad (143)$$

Note that these values are valid for the electron when referenced to the Hartree energy frame, but the laboratory measured values for the electron are in the Rydberg frame. This frame shift concept then affects only the lepton mass formulas and they are adjusted as follows:

$$m_\mu/m_e = 3/K_{eH}K_\mu(\alpha f_{uHze}/1 \text{ Hz}); \quad (144)$$

$$m_\tau/m_e = 6/(\alpha f_{uHze}K_\mu^2/1 \text{ Hz})[(a_{eH}/a_\tau)\alpha f_{uHze}K_\mu^2/1 \text{ Hz}]^{1/2}, \quad (145)$$

or

$$(m_\tau/m_e)^2 = 4(m_\mu/m_e)^3/[3(a_{eH}/a_\tau)(K_\mu/K_{eH})^3], \quad (146)$$

$$m_{ss}/m_e = 9[(\alpha f_{uHze}K_\mu^2 - 1 \text{ Hz})(\alpha f_{uHze}K_\mu^2 - 1 \text{ Hz})], \quad (147)$$

or

$$m_{ss}/m_e = (m_\mu/m_e)^3[(a_\mu/a_{eH})(K_\mu/K_{eH})^3], \quad (148)$$

$$m_{ss}/m_e = 12[(\alpha f_{uHze}K_\mu^2 - 1 \text{ Hz})(\alpha f_{uHze}K_\mu^2 - 1 \text{ Hz})] \\ \times 1/(\alpha f_{uHze}K_\mu^2 - 1 \text{ Hz})^{1/2}; \quad (149)$$

or

$$(m_{ss}/m_e)^2 \\ = 2(m_\mu/m_e)^3[3(a_\mu/a_{eH})(K_\mu/K_{eH})^3]; \quad (150)$$

These revised mass formulas produce the mass values

$$m_\mu/m_e = 206.768\,248\,833 \quad (151)$$

and compare with the experimental value,<sup>44</sup> 206.768 262 (0.15 ppm), at the 0.06 ppm level.

$$m_\tau/m_e = 3492.505 (1.784\,667 \text{ GeV } m_e C^2), \quad (152)$$

which compares with the experimental value,<sup>44</sup> 1.7841 (0.2%), at the 300 ppm level;

$$m_{ss}/m_e = 42\,522.309 (43.457\,720 \text{ GeV } m_e C^2 \text{ per pair}) \quad (153)$$

and compares with CELLO data<sup>45</sup> [43.450 GeV  $M_e C^2$  (?) at the 178 ppm level.

$$m_{s_2}/m_e = 572\,980.171\,287 \\ \times (292.792\,328\,926 \text{ GeV } m_e C^2), \quad (154)$$

and the coupling constant for neutron decay becomes

$$(K_\mu K_{eH})^{1/2} = 1.000\,042\,206\,415\,159, \quad (155)$$

which produces a coupling system energy of

$$E_d = (K_\mu K_{eH})^{1/2} m_{s_2} C^2 = 292.804\,686\,664 \text{ GeV}, \quad (156)$$

also yielding a Fermi constant value of

$$G_F = 1/E_d^2 = 1.166\,390\,443 \times 10^{-5} \text{ GeV}^{-2} \quad (157)$$

and compares with experiment,<sup>44</sup> 1.166 39  $\times 10^{-5} \text{ GeV}^{-2}$  (17 ppm), at the 1 ppm level of precision.

There exist several predictions of lepton and particle mass formulas. One approach<sup>(5,6)</sup> suggests that an additional convective current can be added to the relativistic Lorentz-Dirac equation such that the masses can be developed in a truncated series manner. The result of this approach produces the following formulas for lepton masses:

$$m_\mu m_e = 3 \cdot 2\alpha + 1 = 206.55 \text{ [0.1\%]}; \quad (158)$$

$$m_\tau m_e = 1 + (3 \cdot 2\alpha)1^2 + (3 \cdot 2\alpha)2^2 = 3495.42 \text{ [0.1\%]}; \quad (159)$$

$$m_\tau m_e = m_\mu m_e + (3 \cdot 2\alpha)3^2 = 20145.3 \text{ (?)}. \quad (160)$$

This approach is different from the HYDRA method, and the difference becomes apparent at the fourth lepton level where HYDRA produces a value for the 5S lepton of 42522, which is twice the value for the predicted 4 lepton. There was no specific value predicted for a fifth lepton.

Barut concludes his work with the following statement, which echoes our feelings:

It is possible that although the Bohr-Sommerfeld quantization is approximative, the final result might be exact as was the case in Bohr-Sommerfeld derivation of the Balmer formula. Therefore, the hypothesis which I advance should be considered of a heuristic nature towards the development of a more complete theory. On the other hand, the occurrence of the fermion chain  $e, \mu, \tau, \dots$ , is a novel phenomenon for which we have so far no theory in order to derive a mass formula from first principles: "We have no plausible precedent for, nor any theoretical understanding of this kind of superfluous replication of fundamental entities. Nor is any vision in sight wherein the various fermions may be regarded as composites of more elementary stuff. No problem is more basic than the problem of flavor, and it has been with us since the discovery of muons. Sadly, we are today no closer to a solution."

## 10. LAMB SHIFT

The concept of the atomic electron was developed in the second paper,<sup>(2)</sup> and the rich spectroscopic structure produced by the hydrogen atom may be viewed as the excitation of the higher and cross resonances of the HYDRA model. The Sommerfeld fine-structure formula was rederived with this concept.<sup>(2)</sup> The physical mechanism that produces the actual spectral resonances is represented in the model by the excitation of a coupled virtual electron system driven by power coupling at the  $n = 2$  level from the real electron. The manner in which the virtual system and the electron couple is the source of the Lamb shift phenomena. The spectral energy shift at energy level  $n$  is given by HYDRA, Sommerfeld, or Dirac by

$$\Delta E = (\alpha^4 m_e C^2 / 2) / (n^4) [(n/K_2) - (n/K_1)]. \quad (161)$$

Therefore, the frequency of the Sommerfeld transition drive energy ( $n = 2$ ) is given by

$$\Delta E/h = (\alpha^4 m_e C^2 / 2) / (2^4 h) = 10\,949.285 \text{ MHz}. \quad (162)$$

The problem that developed, or what is called the Lamb shift, is the fact that experimental data<sup>17</sup> produced the following unexpected frequency separation of the 2S and 2P<sub>1/2</sub> energy levels, which should have been zero:

$$f_{22} = 1057.85 \pm 0.01 \text{ MHz}. \quad (163)$$

Later work by Sommerfeld produced a perturbation theory corrected calculation value of  $1057.99 \pm 0.2 \text{ MHz}$  that matched the experimental value at the 208 ppm level of precision, but the experimental<sup>17</sup> error is given at the 10 ppm precision level. Recent QED calculations produced values within the experimental precision level.<sup>17,18</sup> The HYDRA model indicates that the hydrogen electron excitation system should appear as given in Fig. 2. The symbol  $e^+$  represents the positron portion of the virtual pair system while  $e^-$  represents the electron portion. The power system coupling takes place at the  $n = 2$  level, and the virtual electron-positron pair system is driven directly by the real electron. The coupling power can be derived and the Lamb-shifted frequencies calculated via this virtual particle concept.

The virtual pair system power originates in the small energy difference produced by the electron shifting from the Rydberg to Hartree energy frame as well as the effect of the change in the total electron-proton system energy (reduced mass effect). Essentially, the shift to the Hartree reference system permits an  $n = 2$  coupling system, since  $f_{uHz}$  shifts to approximately 2. The defining equations for the electron in the hydrogen system are given by

$$K_{eH}^2 = \frac{[1 - (\alpha f'_{uHz}/1 \text{ Hz})^2][1 - (\alpha f'_{uHz}/\alpha f'_{uHze})(\alpha/2\pi)]^2}{[1 - (\alpha f'_{uHz}/1 \text{ Hz})^2][1 - (\alpha/2\pi)^2]}. \quad (164)$$

$$a'_{eH} = (1 + a_e K_{eH}^2) / [1 - (\alpha f'_{uHz}/\alpha f'_{uHze})(\alpha/2\pi)]^2 - 1, \quad (165)$$

$$f'_{uHze} = (\mu_e/\mu_B - \mu_B/\mu_e) 1 \text{ Hz} [1 - (\alpha/2\pi)^2] / a'_{eH}. \quad (166)$$

The parameters  $f_{uHze}$ ,  $K_{eH}$ , and  $a_{eH}$  are valid parameters to use in individual particle (lepton) coupling systems, but the existence of a nucleus, in the atomic case, requires that these parameters must be modified for the combined system. In the atomic case, the existence of the nucleus affects the basic system frequency ( $f_{uHz}$ ) in the following two ways. First, this frequency is reduced by the standard reduced mass correction for hydrogen by the following factor:

$$\begin{aligned} \mu_f &= \mu/m_e = [(m_e m_p)/(m_e + m_p)]/m_e \\ &= 0.999\,455\,679\,433 \end{aligned} \quad (167)$$

and the second involves the presence of the nucleus which produces a spin reference system for the electron such that the electron appears to have the azimuthal velocity of  $\alpha C f'_{uHze}/1 \text{ Hz}$ . This effect further reduces system mass and appears in the Rydberg to Hartree reference frame shift as

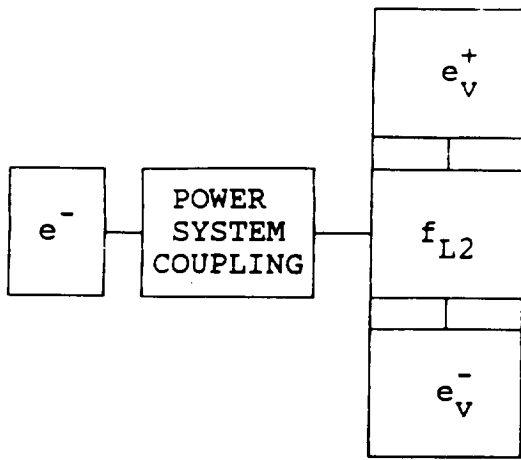


Figure 2. Electron-virtual pair system.

$$\mu_H = [1 - (\alpha f'_{uHz} / 1 \text{ Hz})^2]^{1/2} = 0.999893646548. \quad (168)$$

These two factors produce a reduced system frequency ( $f'_{uHz}$ ) of

$$f'_{uHz} = \mu_f \mu_H f_{uHz} = 1.0014447090813 \text{ Hz}. \quad (169)$$

When  $f'_{uHz}$  is used explicitly in the calculation of  $K'_{eH}$  and  $a'_{eH}$ , the following values are produced:

$$f'_{uHz} = 1.998544791740 \text{ Hz}, \quad (170)$$

$$a'_{eH} = 1.159822903856 \times 10^{-3}, \quad (171)$$

$$k'_{eH} - 1 = 5.05093963 \times 10^{-7}. \quad (172)$$

Now that the Hartree coupling factor has been calculated for the electron within the hydrogen system, the stage is set to calculate the energy or frequency shift due to the electron coupling with the virtual electron system to form the total oscillation structure that introduces a slight shift in the spectral frequencies.  $K_{eH}$  is a second-level ( $n = 2$ ) coupling constant, since  $f_{uHz}$  is approximately 2, and no azimuthal excitation has been included. Therefore, this coupling should produce the Lamb shift in the  $n = 2$  spectral lines and drive the Lamb-shifted frequency system, or  $K'_{eH}$  should be properly designated as  $K_{eH2}$ .

Basically, this coupling offsets the frequency structure by the additional frequency produced by the greater-than-1 value of  $K_{eH2}$ , since the value 1 frequency ( $f_c$ ) is already present in the system, or

$$f_\Delta = (K_{eH2} - 1)f_c. \quad (173)$$

This virtual pair coupling frequency then connects with the electron system to transfer energy via the quantized power circulation, or

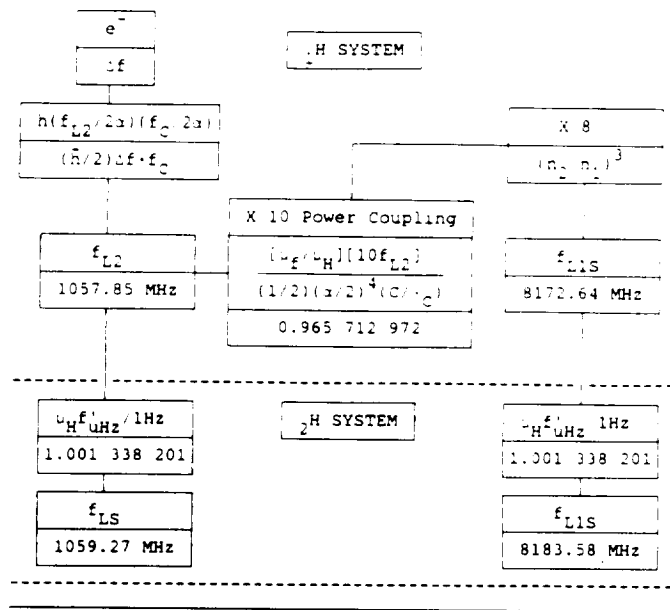


Figure 3. 1S Lamb shift system.

$$P_{L2} = (\hbar/2)f_\Delta f_c. \quad (174)$$

Now the power coupling between the Lamb spectral shift system ( $f_\Delta$ ) and the electron base system ( $f_c$ ) is given by

$$P_{L2} = h(f_L/2\alpha)(f_c/2\alpha). \quad (175)$$

Since these powers must be equal, the Lamb frequency for the 2 level is given by

$$f_L = 1057.857905 \text{ MHz} \quad (176)$$

and agrees with the experimental value<sup>10</sup> 1057.85 MHz (10 ppm) of the 2S - 2P<sub>1/2</sub> offset at the 7.5 ppm level of precision.

This frequency is the offset between the 2S and 2P<sub>1/2</sub> spectral lines and is also the driving frequency of the entire hydrogen line spectral system. Figure 3 is a power or frequency flow diagram for the 2S and 1S lines in hydrogen and has been extended to deuterium via one azimuthal unit shift. Essentially, the  $f_L$  frequency cannot drive the structure directly since the  $n = 2$  Sommerfeld driving frequency is  $(1/2)(\alpha/2)^4(C/\lambda_c)$ , 10949.285 MHz, which is a factor of ten higher than  $f_L$ . Note that the tenth harmonic of  $f_L$  is closer to the correct Sommerfeld driving frequency than either the ninth or eleventh. Either the tenth harmonic coupling of  $f_L$  up to the Sommerfeld frequency or the tenth subharmonic down-coupling of the Sommerfeld frequency is necessary for  $f_L$  to drive a spectral system; whichever system is selected will not produce a perfect match, resulting in a coupling shift factor.

Prior to coupling, the Sommerfeld drive frequency must be reduced by  $\mu_H$  to account for the Hartree frame mass reduction, and  $f_L$  must be reduced by  $\mu_f$  to place the Lamb

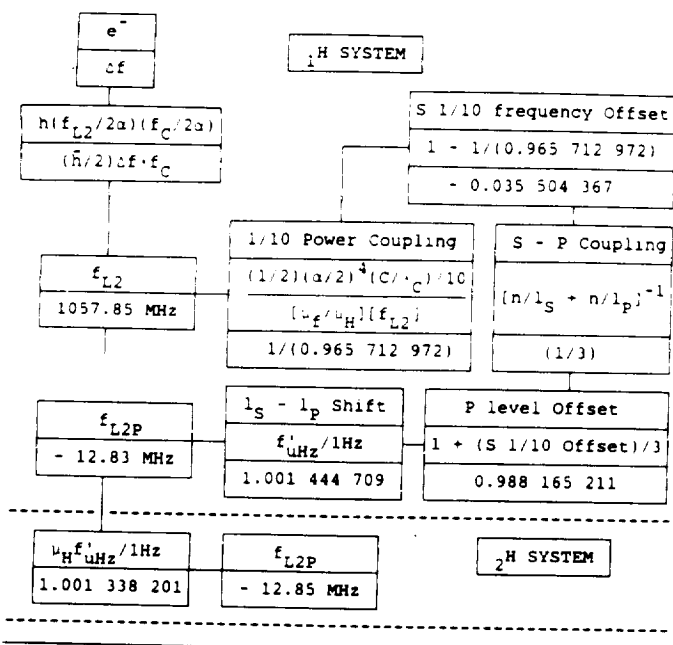


Figure 4. 2P Lamb shift system.

system in the reduced mass system. Note that  $f'_{uHz}$  has not yet been introduced to the Lamb system, but was used in the real electron system to develop a specific value for the Lamb driving frequency. If no virtual electron system were produced, there would be only one Lamb spectra line (2S). Since  $f_{L2}$  must climb up to reach the higher frequency  $n = 1$  spectral level, it up-couples or uses the tenth harmonic coupling to reach the Sommerfeld driving frequency level. Then it couples to the  $n = 1$  level within the Sommerfeld-Dirac levels via a factor of 8 ( $n^3$ ). This power flow produces a shifted 1S spectral line offset of 8172.64 MHz (there is no 1P level offset) which compares with experiment<sup>(7,8)</sup> [8172.58 MHz (84 ppm)] at 7 ppm.

The presence of the added neutron in deuterium affects the electron structure by shifting it into the next higher frequency reference level or escalates the entire frequency structure by a factor of  $f'_{\text{uHz}}$  and  $\mu_{\text{H}}$  which again reduces the system mass because of this frame shift. For deuterium the  $f_{\text{L5}}$  line shift is 1059.27 MHz, which compares with experiment,<sup>(5)</sup> 1059.28 (57 ppm), at the 9 ppm level. The  $f_{\text{L15}}$  value of 8183.58 MHz compares with experiment,<sup>(7)</sup> 8183.74 MHz (77 ppm), at the 20 ppm level. Tritium is expected to shift a factor of  $\mu_{\text{H}}$ .

The 2P level shift is depicted in Fig. 4, where the  $f_{L2}$  driving frequency uses inverse coupling or downshifts to the lower frequency P level, within the Sommerfeld structural level. It does not pass through the Dirac level and therefore couples through  $n/l$ . The direct offset of the 2S coupling frequency appears both at the S and P levels, since this  $n = 2$  structure is created directly by  $f_{L2}$ , but the effect on the P level offset is reduced by a factor of 3. Note that this inverse coupling

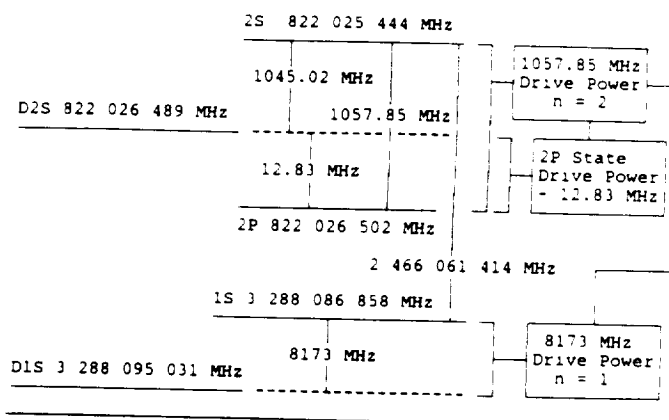


Figure 5. Lamb shift energy level diagram.

changes the sign of the offset from the driving frequency so that the 2P Lamb shift is opposite to the 2S and 1S shifts. The last factor accounts for the l-state shift from S to P. The calculated 2P Lamb shift,  $-12.83$  MHz, agrees well with the listed theoretical (QED) value,<sup>(7,8)</sup> which does not contain a precision estimate.

Figure 5 gives the total power flow diagram for the virtual electron spectral system. The Dirac energy levels contain all factors, excluding the Lamb shift. The Dirac energy levels and the associated spectral line offsets are not directly observable. Note that the difference of the 2S and 2P offsets (1057.85 MHz) is directly observable and this frequency is also the virtual pair driving frequency. The 1S Lamb shift is derived from an absolute measurement of the 1S - 2S transition spectral line. There appears to be a 1 MHz frequency difference in the observed value of this transition.<sup>(7-9)</sup> Such a difference could be explained by the virtual pair coupling system shifting the 1S state by one reference frame unit or by replacing  $\mu_H$  in Fig. 3 with  $\mu_H^+$ , shifting  $f_{11S}$  by approximately 1 MHz. Possibly, an excited state of a hydrogen system may be produced by differences in the hydrogen injection nozzle temperature or the hydrogen dissociator operating frequency.

## 11. HUBBLE CONSTANT

The basic relationship between the gravitational and electrical systems was derived as

$$f_c f_B = (\alpha/2) f_{\text{uHz}}^2, \quad (177)$$

and if inverse coupling is calculated, then

$$f_c f_H = (2/\alpha) f_{H_2}^2, \quad (178)$$

where  $f_H$  represents an inverse coupling frequency. This sets the previous normalized frequency relationship as

$$f_C f_C f_g f_H = f_{\text{UHZ}}^4 \quad (179)$$

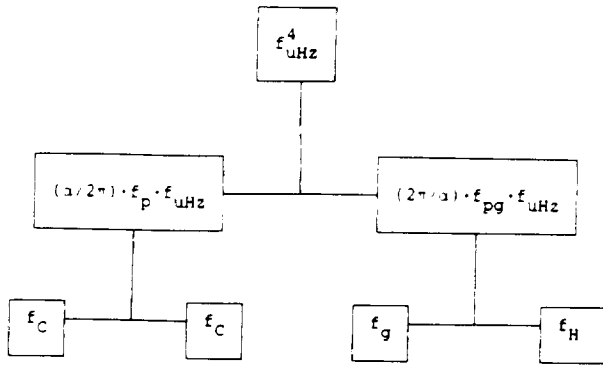


Figure 6. Zero-order electron frequency structure.

Figure 6 depicts the electron frequency structure in this form, and the numerical value of  $f_H$  is calculated as

$$f_H = (2/\alpha)(\lambda_c/C)f_{uHz}^2 = 2.227458 \times 10^{-18} \text{ Hz.} \quad (180)$$

This frequency is identified as the Hubble frequency in that the presently accepted value,<sup>(4)</sup> in hertz, is given as

$$H_0 = 1.296 - 3.241 \times 10^{-18} \text{ Hz.} \quad (181)$$

The currently accepted age of the universe is approximately the inverse or period of the Hubble constant, or 15 billion years.<sup>(4)</sup> The inverse of  $f_H$  is 14.23 billion years. Therefore, the product of  $f_g$  and  $f_H$  can be considered to represent the cross power flow between the electron's gravitational system and the gravitational field. This cross flow establishes the electron's position within the gravitational universe. The  $f_c f_c$  represents the self-power flow of the electron's electrical system. These cross flows are then related inversely at the Planck frequency level. The Hubble constant probably represents the spin or angular frequency of space which would mean that space, has an inherent circulation or that the gravitational field contains a finite curl component with a characteristic frequency of  $f_H$ .

## 12. FUNDAMENTAL ELECTRON FREQUENCY STRUCTURE

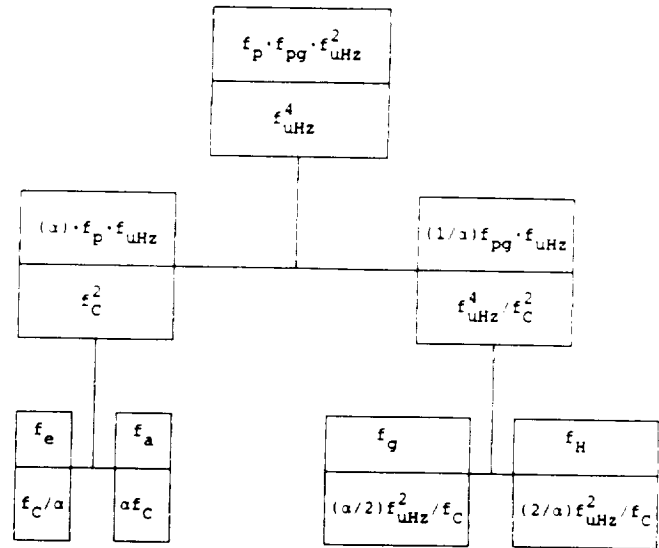
There are many ways to represent the frequency structures produced by the HYDRA model. Perhaps the clearest representation is given by redefining the parameter  $f_c$  such that angular frequency is set as  $v/r$ , or that

$$\omega_c = v/r = C/r_e = 2\pi f_c, \quad (182)$$

which sets the new definition of  $f_c$  as

$$f_c = C/2\pi r_e = C/\alpha \lambda_c = f_c/\alpha \quad (183)$$

and define an atomic frequency from the Bohr radius ( $a_0$ ) as



$$f_{uHz} = \alpha \text{ Hz} [\pi(\mu_e \mu_B - \mu_B \mu_e)(1 - (\alpha/2\pi)^2)^{-1/2}]$$

$$= 1.0020966734 \text{ Hz}$$

$$f_p = 1/(2\pi\sqrt{2}t_p) = (C^5/4\pi h G)^{1/2} = 2.087726904 \times 10^{-42} \text{ Hz}$$

$$f_{pg} = f_{uHz}^2/f_p = (4\pi h G/C^5)^{1/2} f_{uHz}^2 = 4.810005274 \times 10^{-75} \text{ Hz}$$

$$f_c = C/\lambda_c = (m_e C^2)/h = 1.235589843 \times 10^{20} \text{ Hz}$$

$$\lambda_c = h/(m_e C) \quad f_c = C/(2\pi r_e) = f_c/\alpha \quad f_a = C/(2\pi a_0) = \alpha f_c$$

$$r_e = \text{classical electron radius} = (\alpha/2\pi)\lambda_c$$

$$a_0 = \text{Bohr radius} = \lambda_c/2\pi\alpha = r_e/\alpha^2$$

Figure 7. Fundamental electron frequency structure.

$$\omega_a = v/r = C/a_0 = 2\pi f_a, \quad (184)$$

which sets the definition of  $f_a$  as

$$f_a = C/2\pi a_0 = \alpha(C/\lambda_c) = \alpha f_c. \quad (185)$$

Now the frequency structure appears as given in Fig. 7, which clearly shows the inverse relationships between the frequency pairs. Both the atomic and nuclear states are represented on the left side, while the right side shows the gravitational coupling between the Hubble and gravitational frequency systems. These frequency pairs are similar to the group and phase velocities of wave theory and their interchange defines the physical atomic and nuclear states of the electron.

## 13. PHYSICAL CONSTANT VALUES

Taylor and Cohen<sup>(10)</sup> reviewed the status of recommended values for the fundamental physical constants and, if adopted, would result in the following new values:

$h = 6.626\,068\,211 \times 10^{-34} \text{ J}\cdot\text{s}$	(0.14 ppm)
$e = 1.602\,176\,433 \times 10^{-19} \text{ C}$	(0.068 ppm)
$m_e = 9.109\,380\,135 \times 10^{-31} \text{ kg}$	(0.14 ppm)
$\alpha = 7.297\,352\,934\,8 \times 10^{-3}$	(0.0069 ppm)
$\mu_B = 9.274\,009\,836 \times 10^{-24} \text{ J}\cdot\text{T}$	(0.07 ppm)
$\lambda_C = 2.426\,310\,476 \times 10^{-12} \text{ m}$	(0.014 ppm)
$[\mu_e/\mu_B - \mu_B/\mu_e] = 2.317\,961\,141\,3 \times 10^{-4}$	(0.0074 ppm)
$a_e = 1.159\,652\,188\,4 \times 10^{-3}$	(0.0037 ppm)
$f_{\text{uHz}} = 1.002\,096\,673\,4 \text{ Hz}$	(0.0069 ppm)
$G = 6.672\,527\,5 \times 10^{-11} \text{ m}^3/\text{kg}\cdot\text{s}^2$	(0.14 ppm)
$t_p = 5.390\,529\,733 \times 10^{-44} \text{ s}$	(0.028 ppm)
$f_c = 1.235\,589\,843 \times 10^{20} \text{ Hz}$	(0.014 ppm)
$f_e = 1.063\,870\,696 \times 10^{23} \text{ Hz}$	(0.014 ppm)
$f_g = 2.965\,379\,402 \times 10^{23} \text{ Hz}$	(0.014 ppm)
$f_{gc} = 2.586\,991\,717 \times 10^{21} \text{ Hz}$	(0.014 ppm). (186)

The following series expansion can be used to develop calculated physical constant values:

$$\begin{aligned}
 (\mu_e/\mu_B) = 1 & \\
 & + [(1 \text{ Hz})/\sqrt{2}t_p f_c^2 [1 - (\alpha/2\pi)^2]^{1/2}] \\
 & + (1/2)[(1 \text{ Hz})/\sqrt{2}t_p f_c^2 [1 - (\alpha/2\pi)^2]^{1/2}]^2 \\
 & - (1/8)[(1 \text{ Hz})/\sqrt{2}t_p f_c^2 [1 - (\alpha/2\pi)^2]^{1/2}]^4 + \dots, \quad (187)
 \end{aligned}$$

which yields the value for  $a_e$

$$a_e = \mu_e/\mu_B - 1 = 1.159\,652\,190 \times 10^{-3}, \quad (188)$$

which compares with the experimental value,  $1.159\,652\,188\,4 \times 10^{-3}$ , at the 0.002 ppm level of precision.

These new values for the constants do not affect the calculation of the gravitational constant ( $6.672\,527\,5 \times 10^{-11} \text{ m}^3/\text{kg}\cdot\text{s}^2$ ), since the earlier value of  $6.672\,521\,8 \times 10^{-11} \text{ m}^3/\text{kg}\cdot\text{s}^2$  is in agreement with experimental data,  $6.672\,59 \times 10^{-11}$  (128 ppm)  $\text{m}^3/\text{kg}\cdot\text{s}^2$ , at the 10 ppm level. The change in the value of  $G$  is 1 ppm and is primarily due to the new value and precision of  $h$ .

#### 14. COMPARISON WITH RECENT QED CALCULATIONS

Quantum electrodynamics is one of the most important contributions to modern physics in the present century. While the basic tenets of the theory are elementary, the application process is extremely complex. The most recent work involving the calculation of the electron's magnetic moment anomaly ( $a_e$ ) by Kinoshita and Lindquist<sup>33</sup> in terms of the fine structure constant ( $\alpha$ ), in the words of Taylor and Cohen,<sup>34</sup> has "advanced markedly in the last 3 years due to the Herculean QED calculations of Kinoshita and co-workers."

This approach does not lead to a closed or exact relationship between these two fundamental physical constants. It results in an infinite series expansion of the form

$$a_e = C_1(\alpha/\pi) + C_2(\alpha/\pi)^2 + C_3(\alpha/\pi)^3 + C_4(\alpha/\pi)^4 + \dots \quad (189)$$

where each coefficient is evaluated independently. Both  $C_2$  and  $C_3$  result in negative values and  $C_1$  is exactly 0.5. This result implies that  $a_e$  is of the form  $[1 + (\alpha/\pi)]^2 - 1$ , but cannot be reduced to such a form since the coefficients are floating and evaluated individually. The process is somewhat similar to polynomial expansion curve fitting. However, for the expansion of a single value, an infinite number of solutions is possible. The physical process by which these coefficients are determined is, in essence, the QED method. Obviously, this technique is not incompatible with an exact or closed solution, which is the HYDRA approach.

In comparison, the HYDRA model contains an infinite number of higher-order term pairs that are connected via cross-power relationships that are directly related to particle mass. The higher-order term masses are identified as inertial mass, while the single zero-order term contains the gravitational mass. As long as no discrepancy is found in the equality of inertial and gravitational mass, the basic relationship between the fundamental constants can be derived from the zero-order term, in closed or exact form.

Therefore, HYDRA and QED are not mutually exclusive in any way. They are not directly comparable internally since the QED expansion coefficients cannot be extracted from the HYDRA model, nor can the gravitational constant ( $G$ ) be extracted from the QED model. In principle, the QED technique continuously recreates the gravitational constant within the inverse conjugate wave function (Hermitian) through the renormalization process. The constant  $G$  is probably piecewise scattered throughout the higher-order QED terms in the form of normalization constants.

However, this QED weakness is also its strength in that it does not depend on the explicit value of  $G$ , which is only accurate to 128 ppm. Therefore, QED can drive the theoretically corrected value of  $\alpha$  up to the experimental precision of  $a_e$ , which is accurate to the ppb level of precision. The weakness of HYDRA is also its strength in that it contains  $G$  explicitly and results in exact solutions. Therefore, the precision level of  $G$  can be improved many orders of

magnitude through the relationships with  $a_e$ , but not vice versa. HYDRA describes the magnetic moment anomaly in the form

$$1 + a_e = [(1 + k)/(1 - k)]^{1/2} = [1 + 2k/(1 - k)]^{1/2} \quad (190)$$

and moves toward a direct calculation of  $k$ , which is

$$k = [1 + (\sqrt{2} \lambda_p (1 - (\alpha/\pi)^2)^{-1/2} / ((\alpha/\pi) \lambda_p (2\pi C)(1 \text{ Hz}))^2)^{-1/2} \quad (191)$$

$$k = 1.158979792 \times 10^{-4} \quad (192)$$

or

$$k = (0.498953858)(\alpha/\pi) \quad (193)$$

This is a highly accurate value, since  $G$  was evaluated to a high degree of accuracy with the current value of  $a_e$ . In other words, HYDRA does not calculate the value of  $a_e$  directly, since  $G$  is so poorly known. If  $G$  can be determined to the 0.1 ppm level experimentally, then the independently calculated value of  $a_e$  by HYDRA will have considerable meaning. HYDRA's value, within the context of the QED calculations to extend the accuracy of  $a_e$  to  $\alpha$ , is that the accuracy of  $a_e$  and the other constants ( $h$ ,  $e$ , etc.), whose accuracy is extended by QED, can now be extended to  $G$ . Explicitly, this relationship is given by

$$[1 + 2k/(1 - k)]^{1/2} - 1 = a_e \\ = C_1(\alpha/\pi) + C_2(\alpha/\pi)^2 + C_3(\alpha/\pi)^3 + C_4(\alpha/\pi)^4 + \dots, \quad (194)$$

which has combined the strengths of both QED and HYDRA and eliminated the weaknesses of both, since  $G$  is explicitly contained in the evaluation of  $k$ . If one evaluates the numerical value of  $k$  from  $a_e$ , an expansion can be developed of the form

$$2k/(1 - k) = (1.013318851)(\pi\alpha), \quad (195)$$

which produces the following expansion:

$$a_e = [1 + (1.013318851)(\pi\alpha)]^{1/2} - 1; \quad (196)$$

$$a_e = (1/2)(1.013318851)(\pi\alpha) - (1/8)(1.013318851)^2(\pi\alpha)^2 \\ + (1/16)(1.013318851)^3(\pi\alpha)^3 + \dots, \quad (197)$$

or in terms of  $\alpha/\pi$ ,

$$2k/(1 - k) = (0.1026706654)(\alpha/\pi), \quad (198)$$

which results in the following expansion:

$$a_e = [1 + (0.1026706654)(\alpha/\pi)]^{1/2} - 1; \quad (199)$$

$$a_e = (1/2)(0.1026706654)(\alpha/\pi) \\ - (1/8)(0.1026706654)^2(\alpha/\pi)^2 \\ + (1/16)(0.1026706654)^3(\alpha/\pi)^3 + \dots \quad (200)$$

and is closer to the QED expansion form, but the first-order term coefficient is a factor of 10 less than 0.5. It should always be remembered that the expansions for HYDRA equations are not necessary, since these relationships are exact solutions; but expanding the HYDRA equations may be useful in comparisons with other techniques such as QED that must be developed within the context of an expansion.

Both HYDRA and QED are valuable tools to analyze physical processes. Common elements between them are that postulated virtual particles and interactions play an active role in these processes. The higher-order terms in HYDRA contain virtual particle coupling constants that can be worked backwards to develop particle coupling constants or matrices. QED expands each coefficient into multiple virtual particle interactions (vertices) so that each expansion term contains the interaction of virtual particles operating as higher-order corrections to each term (muon, tau, weak particles) in the form of currents.

While the algebraic comparisons of HYDRA and QED are somewhat abstract, a simpler analogy can be drawn. HYDRA focuses on power and resonant frequencies within the context of a system operating at rated power (quantized system). If one owned a factory whose lighting system operated at rated power and contained a thousand light bulbs, the operating power could be determined in two ways. One would be to send a crew out into the factory and have them log the power of each light bulb and add them up. This is the QED approach. An alternate solution is to go to the power substation that feeds the warehouse and determine the rated power of this source. This is the HYDRA technique, since the two values must be identical. The load must equal the source power. The weakness of HYDRA is that it does not give the power level of each individual light bulb. The weakness of QED is the effort necessary to calculate the total power. While this is a very simplistic comparison, it is a valid and useful viewpoint.

## 15. THE ELECTRONIC TANK CIRCUIT

The basic concept considered in this section deals with the possible mode of interaction between two charged particles without specifically addressing the nature of the coupling fields. It essentially models the two particles as a coupled resonant system or tank circuit with a primary and secondary system. This is similar to a resonant tank circuit in a radio frequency transmitter.

The electron has a characteristic resonant frequency (slow wave) of  $C/\lambda_e$ , or about  $10^{20}$  Hz. It also resonates gravitationally at about  $10^{-23}$  Hz and contains a spin cross frequency of about  $10^{-3}$  Hz. The free space ( $\epsilon_0$ ) resonance is the high frequency value, and we will consider this as its physical space

resonance, although free space ( $\epsilon_0$ ) may respond in such a manner to permit direct  $f_c$  coupling as well as  $10^{17}$  Hz coupling, which would electrically make the electron appear to have a physical size much greater ( $10^{11}$ ) than its  $\epsilon_0$  value.

Therefore, one can take the position that all frequencies that exist or circulate in the electron system modulate the main (carrier) frequency of  $10^{20}$  Hz. The resonant tank circuit concept then requires that energy transfer between particles occurs through modulation impressed on the high-frequency carrier. Low or significantly off-resonance frequencies cannot directly couple from primary to secondary circuits unless the quality ( $Q$ ) of the resonant circuits is extremely low. Of course, atomic and nuclear resonances exhibit the highest  $Q$  values of any systems known to exist. High-quality microwave circuits can be constructed with  $Q$  values of several hundred thousand, while atomic spectral lines exhibit  $Q$  values in the millions.

Quality  $Q$  in this context can be defined as the spectral frequency divided by the spectral linewidth in hertz, without thermal broadening. The nuclear electron broadening is probably less than 1 Hz, which would set the  $Q$  value at  $10^{20}$ , but is likely much higher and on the order of  $10^{40}$ . This means that the electronic tank circuit cannot accommodate modulation frequencies of  $10^{23}$  Hz ( $C/r_e$ ) or  $10^{17}$  Hz ( $\alpha C/\lambda_c$ ), but could theoretically transfer a spin frequency ( $10^{13}$  Hz) if the  $Q$  is as low as  $10^{20}$ . The gravitation frequency of  $10^{23}$  Hz can easily be transferred with a  $Q$  of  $10^{20}$  and is certainly possible even with a  $Q$  of  $10^{40}$ . With this hypothetical concept of resonant circuit free space coupling, the modulation of the circulating currents can be addressed.

There are many possible choices of modulation concepts (amplitude, frequency, phase, sideband, or even pulse), and we will use amplitude modulation as the selected example. Obviously, this modulation concept opens up many potential areas of investigation. The low-frequency gravitation current would produce an upper and lower sideband frequency that is deviated from the carrier frequency ( $10^{20}$  Hz) by the gravitation frequency ( $10^{23}$  Hz). The upper sideband may be modeled as  $180^\circ$  out of phase with the lower sideband frequency, which we will take as our phase reference (i.e., the lower sideband signal is the phase reference). These sideband signals exist with or without a carrier (charge) signal.

When two particles interact (primary and secondary circuits), they simply phase lock the upper and lower sidebands and exchange energy (attract). With no carrier (charge) frequency present, this interaction is equivalent to a double sideband radio frequency (RF) system. Essentially, the neutron and charge neutral atom could be viewed as a double sideband RF transmission system.

The circulating atomic electron simply suppresses the carrier frequency energy or signal, but phase locks onto the sideband energy and effectively adds to the sideband energy by an amount equal to its gravitational mass energy. Thus the gravitational signal increases by an amount equal to the mass

energy of the electron. The two sidebands create a phase reference system (since they are  $180^\circ$  out of phase) and set the platform for other signal (force) interactions. They also set up two independent pathways for energy transfer. This establishes the phase reference system for the strong carrier (charge) interaction or energy coupling. The carrier signal is introduced as being either  $+90^\circ$  or  $-90^\circ$  out of phase with the reference lower sideband, which permits two types,  $+$  and  $-$ .

If one creates a charged system where the two sidebands are shifted  $180^\circ$ , the system relocks the sideband phases, and the end result is that the charge carrier shifts  $180^\circ$ . This simply means that the originally created charge sign changes. A simple example would be that the positron is created originally with a negative charge, but with the sidebands shifted  $180^\circ$  from that of the electron. When the electron and positron sidebands relock phase, the resultant positron appears with a positive charge phase. If the electrical carrier system is then taken that phase relationships of the same sign repel and of the opposite sign attract, then we have the electrical force interaction system. Therefore, energy is transferred through the carrier (charge) frequency and the two sideband (gravitation) frequencies.

Much work is needed on this modulation concept, and this example is at a very elementary level, but seems to be a reasonable approach. Such an approach would be critical to the development of a model that describes how the HYDRA current-produced fields interact.

## 16. FUTURE RESEARCH

The cross-coupling matrix requires much work and should be developed to the point that it can be compared with existing nuclear resonance models. Pinpointing the quark resonances will help to construct a HYDRA model of their structure and to predict charge color interaction. This may simply be a phase relationship difference between the basic quark charge or the color charges may, as their title indicates, be charge-characterized by different frequencies, just as gravitational charge (mass) is represented as electric charge functioning at a very low frequency. The nuclear shell model should be examined to see if maximum action coefficients can be developed to explain such observables as magic numbers.

Theoretical field work will require considerable effort along with a reconciliation with the general theory of relativity. The HYDRA model goes directly to the field sources or currents. The proposed modulation concept does not include any cross field interaction. One approach would be to construct displacement currents. Perhaps including some virtual particle within the structure of general relativity would produce additional relationships. By hypothesizing a virtual electron system in vacant space, one might reconstruct the HYDRA model or something equivalent. Nevertheless, the HYDRA model can be worked outwardly to construct resultant fields.



The atomic structure work involves the development of cross-current equations within the spherical cavity formed by the charge motion. This should (electrically) reproduce the Schrödinger wave equations and approaches similar to Russell-Saunders spin orbit coupling schemes. It may produce insight into the origin of selection rules. Initially, it seems that this can be done directly without normalizing the wave function to produce the Hermitian conjugate (inverse) wave function, since the HYDRA model should produce this directly in the form of a gravitation energy wave function.

Much interesting work can be done with the magnetic equivalent of the gravitation field concept. This is a crucial component of the HYDRA model. Its existence may be demonstrated within the framework of astronomical phenomena. Certainly, measuring it in the laboratory would be a challenge. Hypothetical interactions can easily be developed by drawing a direct analogy with Maxwell's equations and using  $\epsilon_0$  and  $\mu_0$  as well as the concept of mass currents.

## 17. ADDITIONAL COMMENTS

The HYDRA work began several years ago as a back-of-the-envelope calculation of the natural electron frequencies that may be present in the upper ionosphere when considering possible driving frequencies within the earth-ionosphere cavity. These low frequencies form in the 3 Hz – 30 Hz range and have been the object of study for nearly a century. This led directly to the estimate of spin and gravitation frequencies that appear in the HYDRA structure. The only applicable value found was  $f_{uHz}$  which is about 1 Hz, close to the range of investigation with  $2\pi f_{uHz}$  barely falling into this range. This led to the discovery of the hypothetical normalization relationship presented in the first paper and later derived from first principles. The HYDRA work has now taken on a character of its own and is a valid area of research in its own right. We propose to continue it, but separate from the earth-ionosphere project. This paper concludes the HYDRA work as developed to this point at this time.

One might pose the question, Why was the HYDRA approach not applied during the early development of quantum physics early in this century? The answer is this: while Maxwell's equations existed, they were not well understood, and their practical applications did not exist during this early period. For example, there were no radio transmitters in those days, much less single sideband radios.

Electrical and mechanical researchers were separated by astronomical distances, not to mention the different systems of units that made communication difficult, if not impossible. It was natural that the first model of the atom was mechanical. Most electrical physicists, such as Steinmetz, were more like electricians and used that title frequently. Their attention was focused on the development of electrical power and communication systems.

Quantum mechanics was not a major area of interest, although electrical wave transmission theory did parallel the Schrödinger wave approach, but no analogies were drawn.

Electrical circuit resonance was just becoming an understood and practical phenomenon. No one derived the gravitation-electric frequency normalization equations. Eddington, Planck, and others worked with specific numerical values, but never applied them to cross currents and therefore did not develop these critical frequency relationships.

Einstein developed field equations, but lacked cross-connecting currents and therefore was missing the relationships necessary to calculate the gravitation constant or the gravitational coupling constant. The lack of precise data on the magnetic moment and its associated anomaly hampered progress, although it was well known that this anomaly existed.

The individual who could have produced an electrical resonance model of the electron early in this century was the master if not inventor of electrical resonance and power – Nikola Tesla. His research and patents in both power and radio are outstanding. His radio patents were recently ruled to precede those of Marconi, and he should rightfully be credited with the invention of radio. His invention of the ac power system that electrifies our modern society is not disputed. It is indeed unfortunate that this genius was ostracized by the scientific and financial community to such an extent that he was unable to contribute to the early development of modern physics.

## 18. SUMMARY

The thick shell (spherical cavity) model of the electron was developed along with associated energies. The Rydberg and Hartree energy reference frames were further discussed. Muon, tau, SS, and SS2 lepton masses and moments were calculated along with the Fermi constant and a Lamb shift concept. The full HYDRA cross-coupling matrix was developed, and the specific coupling constants were calculated for values of  $m$  and  $n$  equal to 3. The concept of the electron as a resonant tank circuit was discussed as well as the potential application of modulation theory. Parallels were drawn with existing theories and models. Future research and applications were discussed. The early development of quantum mechanics was reviewed along with the absence of an electrical resonance model of the electron.

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## Résumé

*Cet article continue le développement du modèle HYDRA et un concept physique du modèle par une coquille sphérique est introduit. Les référentiels de Rydberg et Hartree sont expliqués, la matrice complète des "connexions croisées" est développée, et les concepts de modulation sont discutés. Enfin, les domaines de recherche future et les applications potentielles sont présentées.*

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